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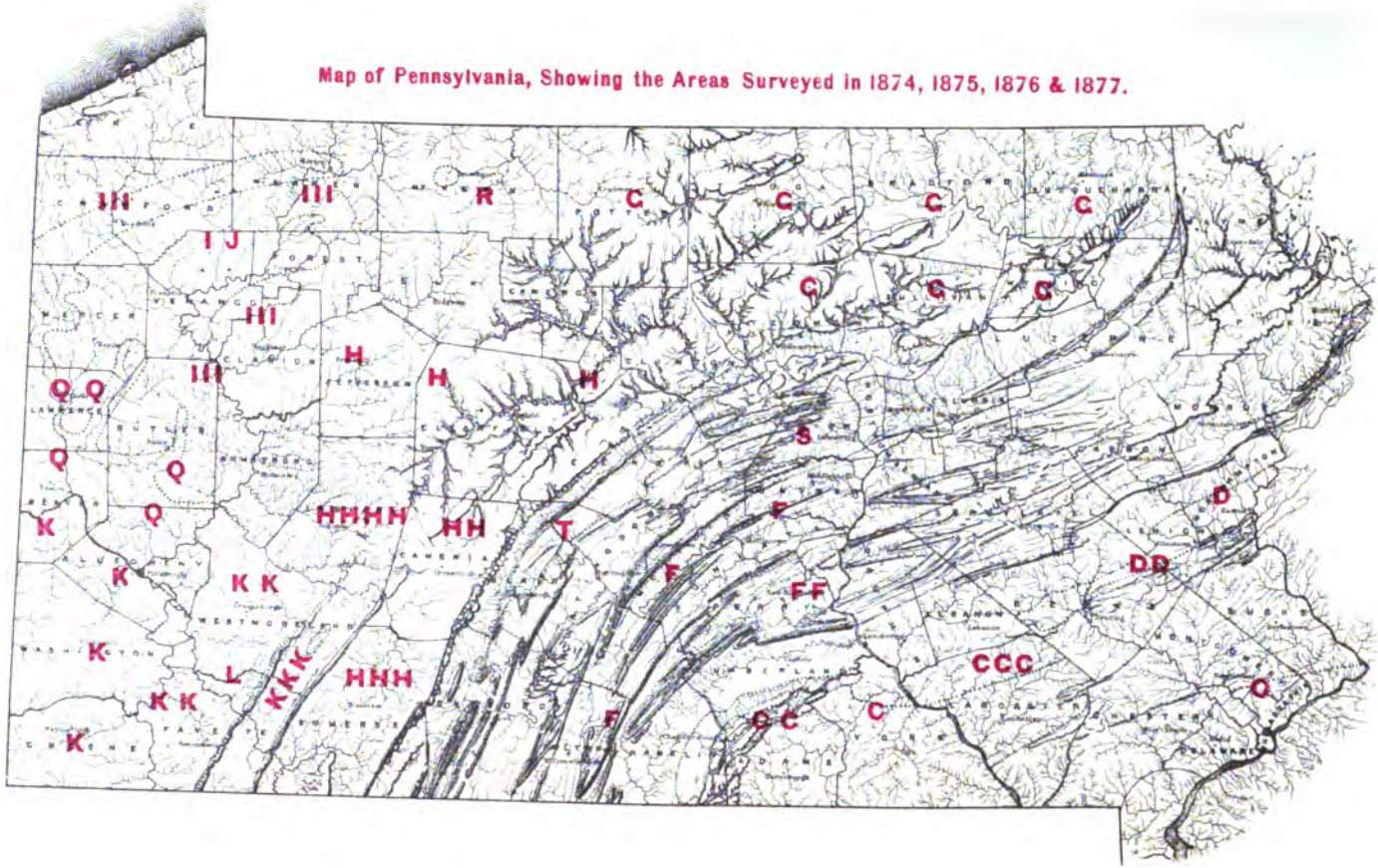

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SECOND GEOLOGICAL SURVEY OF PENNSYLVANIA:
1877.

REPORT OF PROGRESS

IN THE

FAYETTE & WESTMORELAND DISTRICT

OF THE

BITUMINOUS COAL-FIELDS

OF

WESTERN PENNSYLVANIA,

BY

J. J. STEVENSON.

PART II.

THE LIGONIER VALLEY.

Illustrated with 107 Woodcuts, 2 Plates, and 2 County Maps, colored. 4

HARRISBURG:
PUBLISHED BY THE BOARD OF COMMISSIONERS
FOR THE SECOND GEOLOGICAL SURVEY.
1878.

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UNIVERSITY OF THE CITY OF NEW YORK,

April 2, 1878.

Prof. J. P. LESLEY,

Director Second Geol. Surv. of Pennsylvania:

SIR: Herewith I submit Part II of the report upon the Fayette and Westmoreland District, embracing the results of the work during 1877, together with the economic geology of the whole district. Accompanying it are the completed maps of Fayette and Westmoreland counties.

I have again to make grateful acknowledgment of my obligations to the people of the district, for I found everywhere a ready disposition to render all needed assistance, but I must make especial acknowledgment to Messrs. A. D. Ewing, Daniel Kaine, and F. H. Oliphant, of Uniontown; Dr. McGowan and Col. McFarland, of Ligonier, and Mr. D. S. Stewart, of Ohiopyle Falls. Mr. E. K. Hyndman, Supt. Pittsburgh division of the B. and O. R. R., kindly granted free transportation over his road and its branches during 1876 and 1877. I am under very material obligations to Prof. James Hall, Prof. W. B. Rogers, and Prof. Robert Frazer, jr., for assistance during the preparation of this report.

On the maps the areas colored to represent the Pocono are not exact. The outcrops of that rock are for the most part only bluffs in deep ravines, and cannot be given accurately. Some of the areas thus colored are too large, while others doubtless are too small. The intention is merely to show that in those localities the Pocono sandstone is reached. A similar statement should be made respecting the greater number of the little areas colored as Devonian. The Devonian areas have been colored as Catskill, as you directed.

I may not close this letter without expressing my high appreciation of the courtesy and consideration marking your intercourse with me during the three years of my connection with the survey.

Very truly yours,

J. J. STEVENSON.

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INTRODUCTION.

CHAPTER I.

GENERAL DESCRIPTION OF THE LIGONIER VALLEY.

The Ligonier Valley, the second great basin west from the Allegheny Mountains, is a synclinal trough bounded by Chestnut and Laurel ridges, and extends from a little way beyond the West Virginia line northward through Fayette and Westmoreland into Indiana county. Within the Fayette and Westmoreland district its width from crest to crest of the ridges is barely fifteen miles.

The features of the great anticlinal axes bounding the trough will be described in another portion of this volume.

As in other troughs, the dip within the Ligonier Valley is far from regular and the minor folds are so numerous, that at times the structure is somewhat obscure. The main synclinal axis crosses the Conemaugh below New Florence, the Loyalhanna at Ligonier and the West Newton pike about midway between Donegal and Jones' Mills; entering Fayette county, it is thrown off toward the east so as to cross Indian creek near the mouth of Laurel run in Springfield township, the Youghiogheny midway between the mouths of Jonathan's and Bear runs, and the National road at the toll-house, nearly two miles west from the village of Farmington. The subordinate anticlinals are usually insignificant, both in height and in extent. One of them enters the district at Lockport on the Conemaugh and is distinct on the Loyalhanna at three miles west from Ligonier borough. It may be continuous with the southern portion of Chestnut ridge but exposures are so rare along Four-mile run and in its vicinity, that the question of relationship must remain for the present unsettled. Another anticlinal

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crosses the Conemaugh at New Florence, but it is unimportant and, away from the river, it cannot be recognized. A slight fold crosses Mill creek at about four miles from Ligonier and causes a very perceptible flattening of the dip.

In Springfield township of Fayette an obscure axis crosses the Youghiogheny river near Stewarton station; and in Stewart township of the same county, a well marked anticlinal crosses the river just above Ohiopyle Falls, and Beaver run in the same township at a little way below the township line. This axis evidently increases southward, so that on the National road it has pushed the synclinal nearly two miles west from its place, but there it seems to be overridden by Laurel ridge, for the dip on the west slope of that axis from Farmington to within one mile of the crest is barely one degree, and the extreme dip near the crest is but three degrees.

The trough deepens from the Conemaugh to the Loyalhanna, but thence southward it becomes shallow, and the rise is so rapid that, without doubt, the basin points out at but a short distance south from the line of West Virginia. This change is shown by variations in the position of the *Upper Freeport coal bed*, which is 960 feet above tide at New Florence, 780 feet at Ligonier and 1,500 feet on the Youghiogheny, these points being on the line of the main synclinal axis. That the rise continues southward as far as the National road is sufficiently clear, the altitude of the coal bed there being 1,600 feet, but beyond that no satisfactory data could be obtained, as no spirit-leveled line has been run anywhere between the National road and the State line.

The section exposed within the valley extends from the Great Limestone of the Upper Productive Coal Series to the Upper Mauch Chunk shales of the Umbral, while the deep gorges along the mountains are often deep enough to expose not only the Pocono sandstone, but in some instances also the shales and sandstones of the upper Devonian. Within Westmoreland county, the *Upper Freeport coal bed* is deeply buried near the center of the basin, but in Fayette

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it is reached near the central line along all the streams, and along the Youghiogheny it is far up in the hills.

The Surface Features of the Valley.

Geologically the Ligonier Valley is a valley, being a synclinal trough, but topographically it can hardly be considered a valley, as the surface is much broken and, in a large part, its central line is marked by high hills with abrupt slopes. The general altitude gradually increases southward, until, beyond the National road, the Laurel ridge is almost lost; and, were it not for erosion by Big Sandy creek along the base of Chestnut ridge, that mountain too would be merged into the highlands of the valley.

For convenience sake the drainage of the valley may be considered as belonging to four systems, the Conemaugh, the Loyalhanna, the Youghiogheny and the Cheat. Of these the first two are really one, the Loyalhanna being tributary to the Conemaugh, but for our purpose here they are distinct, as the streams do not unite until they pass beyond Chestnut ridge.

The Conemaugh area includes Fairfield and St. Clair townships of Westmoreland county and forms the northern portion of the valley. Its one important stream, Tub-mill creek, rises in Laurel ridge near the southern border of Fairfield township and, crossing the valley, enters the Conemaugh at the base of Chestnut ridge near Bolivar. From each side it receives large tributaries, draining the slopes of both ridges as well as the high divide at the south. The surface within this area is occasionally somewhat abrupt, but nearly all of it, except the steeper slopes of the mountains, is adapted for agricultural purposes. The high divide at the south, separating this from the Loyalhanna area, catches small patches of the *Pittsburg coal bed* and the overlying rocks. The portion, thus favored, is much valued for agricultural purposes.

The Loyalhanna area adjoins the last at the south and includes Ligonier, Cook and part of Donegal township, of Westmoreland county. The Loyalhanna rises at the base of Laurel ridge near the southeast corner of Cook township,

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flows northward to near the middle line of Ligonier, and thence westward to Chestnut ridge, through which it flows in an impressive gap. In the former part of its course it receives a number of small streams from Laurel ridge, which at certain seasons carry a large quantity of water, though during the summer they become insignificant. In the second portion of its course, it receives Mill creek near Ligonier, an important stream draining a large part of Ligonier township, and near the base of Chestnut ridge it is still further increased by Four-mile run, which rises near the southern line of the county and flows northward through Donegal, Cook and Ligonier townships, draining the eastern face of Chestnut ridge.

This area is perhaps the most picturesque within the district and its beauty has given celebrity to the Ligonier Valley. The valley of the Loyalhanna is broad, the high ridges forming divides between the tributary streams are flat-topped and, though in some instances rising to 500 feet above the creek, they seldom show sides too abrupt to admit of cultivation. The Lower Productive Coal Series reaches to the top of Chestnut ridge and far up the western slope of Laurel ridge, so that good farming land may be found at almost all localities within this area.

The Youghiogheny area is separated from the last by a high irregular divide and includes part of Donegal township of Westmoreland, Salt Lick, Springfield and Stewart townships of Fayette, with parts of Dunbar, Wharton and Henry Clay townships of the latter county. It thus embraces the greater portion of Ligonier Valley.

The chief stream entering from the north is Indian creek, which rises in Laurel ridge near the northern boundary of Donegal township and flows southward through Donegal, Salt Lick, and Springfield to the Youghiogheny, which it reaches at the base of Chestnut ridge. On its way, it receives some large tributaries from both sides, which carry much water, as they drain all the mountain slopes between the Youghiogheny and the county line.

The only large stream entering the river from the south

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is Meadow run, which drains a great part of Stewart and Wharton townships.

The Youghiogheny river flows irregularly across the valley in a deep gorge, whose sides rise from 400 to 800 feet above the stream and are so abrupt, that roads with even ordinary grade cannot be made from the river to the surrounding country except at great expense. The gaps through the mountains are enclosed in bold walls, which rise from 800 to 1,300 feet above the river and in many places are so steep, that they can be climbed only with great difficulty. Within these gaps, no large tributaries reach the river. Midway in the valley the highest rocks caught by the hills belong to the Lower Barren Series, while in the heart of the gaps the Upper Devonian is exposed.

Within this area the surface, away from the larger streams, attains great altitude and shows few characteristics of a valley. Where the National road crosses Meadow run the altitude is nearly 1,900 feet, and high flat-topped hills in the vicinity rise to 2,200 feet above tide. For the most part the streams flow in narrow gorge-like valleys with but narrow "bottoms." Much of the surface is still covered by the original forest and a very large part remains to be cleared.

Of the Cheat river area, but a small fragment falls within the Ligonier Valley, and this embraces portions of Wharton and Henry Clay townships of Fayette. The principal stream is the Big Sandy, which heads near the National road, about a mile and a half east from the summit of Chestnut ridge, and flows southwardly into West Virginia, receiving on the way Cheney's and Grosses runs from the west, with some insignificant tributaries from the east. At a little south from the State line, it is increased by the addition of Little Sandy, which rises in Henry Clay township and flows south and west. This latter stream is sometimes known as Glade run and its chief tributary is Gibbon's Glade run.

Within Stewart township, the surface, for the greater part, is quite rugged and most of it is still uncleared; but in Henry Clay township toward Laurel ridge, the character wholly

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changes. Instead of rugged, broken country, one finds there an elevated plain, rising somewhat more than 2,200 feet above tide and diversified only by shallow valleys, so as to be slightly rolling. This region is known as the "Glades" and is part of an extensive area reaching southward into West Virginia and Maryland, but breaking down northward before reaching the National road. By far the greater portion of the glade country is under cultivation and it is well adapted to grazing.

Outlets to Market.

With these the Ligonier Valley is fairly well supplied, having the Pennsylvania Railroad along the Conemaugh, the Latrobe and Ligonier Railroad along the Loyalhanna and the Pittsburg division of the Baltimore and Ohio Railroad along the Youghiogheny. Owing to the extremely rugged surface in the southern portion of the valley the country roads, aside from those following the larger streams, are very bad in respect of both grade and bed. The old Bedford pike, crossing Ligonier township of Westmoreland, has good grades and, having been made well many years ago, is still a fair road at all seasons of the year. The old pike leading from West Newton to Stoystown crosses the valley in Donegal township of Westmoreland, but is thought to be a good road only in winter when all the other roads are impassable. The National road crosses Wharton and Henry Clay townships and is still an excellent road, though in respect of grade it is inferior to the Bedford pike. Aside from these three roads, the means of communication with the region east and west from the valley are very poor, and the so-called roads, leading across the mountains, are for the most part simply marvels of badness. The north and south roads following the larger streams have good grades. If one be not in haste, they can be used with little discomfort in summer, when they are dry, and they are quite good during such portions of the winter as find them covered with snow.

Levels.—To assist the reader in comprehending the surface of the country to be described in this report, the fol-

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lowing tables of heights above mean ocean tide level are appended:

Along the Youghiogheny River. (See Allen's Railroad Levels. Report of Progress N. Table 1, page 5.)

		Feet.
Johnstown, in Cambria county,	(276*)	1184
Sang Hollow Station,	(279.6)	1143
Conemaugh Furnace, where the Conemaugh river leaves the gorge through Laurel Hill Ridge, and enters the Ligonier Valley,	( )	1135
Nineveh Station,	(285)	1121
New Florence Station,	(289)	1076
Houston's Station,	(291)	1056
Lockport Station,	(294)	1054
Bolivar Station, where the Pennsylvania R. R. begins an ascending gradient, on the south slope of the gorge of the Conemaugh river, through Chestnut Ridge,	(295)	1033
Blairsville Junction, overlooking the river at its issue from the west end of the gorge,	(300)	1113
Hillside Station,	(304)	1129
Millwood Station,	(306)	1155
Derry Station,	(308)	1172
Lindorff's Summit,	( )	1185
St. Clair Station,	(310)	1092
Latrobe Station, where the railroad crosses the Loyalhanna river, on its way west to Greensburg,	(313)	1006

Along the Loyalhanna River. (See Allen's Levels, page N. 37, table 32. Ligonier Valley R. R.)

Mitchell's Run, near Latrobe,	1043
Derry Road crossing,	1034
Johnson's Forge, in the gap of Chestnut Ridge,	1040
Iron ore outcrop, 7 miles from Ligonier, and 8 miles from Latrobe,	1044
Kellog's Hollow,	1072
Big Rock Hollow,	1084
Little Rock Hollow,	1100
Baker's Saw Mills,	1121
Buttermilk Falls of the Loyalhanna,	1127
Greensburg and Stoystown turnpike,	1127
Schriner's Run,	1131
Coal Pit Run,	1136
Mill Creek, (surface of water,)	1135
Ligonier, terminus,	1148

* Miles, by Pennsylvania RR. from Philadelphia.

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Along the Youghiogheny River. (*See Allen's Levels, page N. 170. Table 150. Baltimore and Pittsburgh R. R.*)

Confluence, at the junction of the Youghiogheny and Castleman's rivers, at the east end of the gorge, through Laurel Hill Ridge, and on the east line of Fayette county, (66 miles from Cumberland,) 1346
Draketown run, in the gorge, ... ( ) . . . 1319
Egypt station, ... (71) . . . 1302
Ohiopile Falls Station, in the center of the Ligonier Valley, ... (76) . . . 1237
Indian Creek Station, at the entrance to the gorge through Chestnut Ridge, ... (81) . . . 990
Sand Works Station, in the gorge, ... 921
White Rock Station, at the west end of the gorge, and junction with Fayette and Uniontown R. R., . . . (90) . . . 907
Connellsville Station, ... (93) . . . 894

Along the Cumberland Turnpike. (*See Allen's Levels, page N. 168, table 149.*)

Smythfield, on the Youghiogheny river, at the east line of Fayette county, (level of bridge ?) 1465
Barren Hill Summit, (of Laurel Hill Ridge,) 2450
Woodcock Hill, or Briary Mountain, (Laurel Hill Ridge,) . 2500
Laurel Hill, or Most Western Mountain. (This is a misnomer for Chestnut Ridge,) 2412
Munroe, at the western base of Chestnut Ridge, ... 1065
Uniontown, ... 952

Along the Baltimore and Ohio R. R., still further South, in West Virginia, given here to show the gradual elevation of the whole country going South. (*See Allen's Levels, page N.*)

Oakland, (54 miles from Cumberland,) 2371
Hutton's Station, ... (60) . . . 2474
Cranberry Summit, ... (64) . . . 2551
Rodermer's Tunnel, ... (68½) . . . 2083
Rowlesburg, ... (75) . . . 1392
Cheat River, ... 1397
Cassady Summit, ... 1856
Kingwood Tunnel, ... 1778
Tunnelton, ... (82) . . . 1820
Newberry, ... (89) . . . 1215
Independence, ... (90) . . . 1156
Raccoon Run, ... 1227
Thornton, ... (96) . . . 1038
Grafton Junction, ... (102) . . . 985
Benton's Ferry, ... (119) . . . 883
Barnesville, (lowest point,) . . . . . (125) . . . 871

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SYSTEMATIC GEOLOGY.

CHAPTER II.

Nomenclature of the Groups.

In my report for 1875, I used the nomenclature proposed by Prof. H. D. Rogers in the annual reports of the first survey. In the report for 1876 the same system was retained in part, but while the sheets were passing through the printer's hands, I changed the text in some places to agree with the nomenclature then newly proposed by Prof. Lesley. As there was no opportunity to make the necessary explanations of the terms there used, and as some of those into whose hands the former reports have come seem hardly to comprehend the relations of the groups, it may be well here to give in general terms the succession of the several series exposed within the counties covered by these reports.

In the five counties, Greene, Washington, Allegheny, Westmoreland and Fayette, lying west from Laurel Ridge and south from the Ohio and the Conemaugh, the following series are exposed:

XIII. The coal measures.
  1. Upper barren series.
  2. Upper productive coal series.
  3. Lower barren series.
  4. Lower productive coal series.

XII. Pottsville conglomerate (*Seral*).

XI. Mauch Chunk Red Shale (*Umbral*).

X. Pocono sandstone (*Vespertine*).

IX. Catskill group (*Ponent*) with Chemung fossils.

Detailed descriptions of these groups are given in special chapters of the several reports.

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The groups included in this list are seen in succession as one, starting from the southwest corner of the State, rides eastwardly or rather in a north of east direction to the gaps made by the Youghiogheny and Conemaugh through Chestnut and Laurel ridges. The Roman numerals prefixed to the names of the groups are those given by Professors W. B. and H. D. Rogers in the early reports upon the Geology of Virginia and Pennsylvania.

The Upper Barren Series covers by far the greater part of Greene and Washington counties, reaches into southern Allegheny and is represented by small outlying patches in Westmoreland and Fayette west from Chestnut ridge. No fragment of it has been recognized at any locality north from the Ohio and Conemaugh or east from Chestnut ridge. In the Greene and Washington report this group was divided into the Greene and the Washington groups, but on the map no attempt has been made to distinguish these groups. The upper one is confined to Greene and southern Washington, while the lower one is that found at all other localities indicated on the maps.

The Upper Productive Coal Series, the upper portion of which is exposed by some of the deeper hollows under the stronger anticlinals in Greene county, is more or less fully exposed along the Monongahela river from the State line to Pittsburg. This is the surface group in a large portion of Washington and southern Allegheny, as well as in Fayette and Westmoreland. Northward from the Ohio and Conemaugh only insignificant fragments of it remain, while in the Ligonier valley of Westmoreland and the Salisbury basin of Somerset small areas have escaped erosion only to show how widely extensive the region was over which this group at one time stretched.

The Lower Barrens underlie the Upper Coals. Except in the immediate vicinity of the Monongahela river these are wholly below the surface in Greene county, and in by far the greater part of Washington; but in northwest Washington, in Allegheny, Westmoreland and Fayette they are well exposed, making the course of the anticlinals by broad bands of poor soil which widen toward the north until be-

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fore reaching the Ohio and Conemaugh they wholly surround the areas of the Upper Coals or break them up into isolated patches.

The Lower Productive Coal Series, underlying the last, does not appear at the surface in Greene, Washington or southern Allegheny; but the group is exposed further east by the stronger anticlinals; and also at the north, in the direction of the general rise of the rocks, on the Conemaugh River, under the Waynesburg and Saltsburg axes. Along the slopes of Laurel and Chestnut ridges the whole series is brought to the surface. Its rocks line both sides of the Ligonier Valley from the Conemaugh to the State line; and owing to the southward rise of the rocks in that valley, in Fayette county, the upper strata are exposed by the deep gorges in which the larger streams flow through the center of the valley.

In the final report on the First Geological Survey of Pennsylvania the groups numbered 5, 6 and 7 were called the Seral Conglomerate, the Umbral rocks and the Vespertine sandstone, these names having been given to them by Prof. H. D. Rogers according to a fancied analogy to the closing parts of the day, as they were supposed to represent the transition from twilight to dark—of the great paleozoic day, several millions of years long. The inappropriateness of these terms has long been acknowledged, but owing to the fact that the coal bearing series were first fully worked out in Pennsylvania, where these names were employed, they entered so far into the accepted nomenclature that the geologists of the second survey feel some reluctance towards changing them for geographical titles in accordance with the rule accepted by the geological world, as such a change involves the multiplication of synonyms, which is always to be avoided if possible.

Geographical names however have the great advantage of localizing the rocks, thereby giving definite position to them and affording a standard by which to judge of their relations, so that the old names if not wholly dropped should at least be made secondary; the more so, as from the nature of the case, the reports of the Second Survey are

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likely to supplant those of the first. Prof. Lesley, therefore, has applied to these rocks the geographical titles used in Report KK, which will be explained in the succeeding paragraphs.

The Pottsville Conglomerate, or Seral conglomerate of the final report of 1858, underlies the Lower Productive Coals and receives its name from the fact that it has its greatest thickness (1000′) and is most massive in the vicinity of Pottsville in the anthracite region. It is exposed at no point of the surface in southwestern Pennsylvania west from Chestnut ridge, but on both Chestnut and Laurel ridge it is well exposed on each flank, while in Fayette county it shows itself in the gorge of the Youghiogheny in the center of the Ligonier Valley. Within the Fayette and Westmoreland district this mass is known as the Conglomerate, or as the Millstone Grit, the latter name having reference to the use of the rock for millstones.

For the present it is best to retain the term Umbral to designate the rocks immediately below the Pottsville conglomerate, as the series is large and no locality within the State of Pennsylvania so fully shows the characteristics as to justify the application of its name to the whole group. To the various portions of the series the names Upper Mauch Chunk shales, Mountain limestone, Lower Mauch Chunk shales and Silicious limestone are applied in this report.

If it be thought best to replace Umbral by a geographical term, the series might be called the Greenbrier series, from the Greenbrier river of West Virginia. The name Mauch Chunk is objectionable, because at that locality only shales occur, a condition characterizing the series only in central and eastern Pennsylvania, while in all the rest of the enormous area in which this series is exposed there is a large proportion of limestone. In Pocohontas county of West Virginia along the Greenbrier river, as shown by the section given in the Virginia report, the conditions are a mean between the extremes of limestone and shale. So that the locality would be a fitting one from which to name the series.

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The Pocono sandstone is the Vespertine of the old reports and lies directly under the Silicious limestones of the Umbral. It is exposed in the deeper hollows of Chestnut and Laurel ridges and in part along their crests.

The rocks underlying the Pocono sandstone consist of shales and sandstones, which are exposed in the river-gaps through Laurel and Chestnut ridges and occasionally in some of the deeper hollows in the sides of those mountains.*

* By direction of Professor Lesley I have referred these rocks to the Catskill Group, No. IX of the Pennsylvania column. My own conclusions respecting their age are given in the *Amer. Journal of Science*, for June, 1878.

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Chapter III.

The Upper Productive Coal Series.

Rocks belonging to this series occur in Fairfield and Ligonier townships of Westmoreland county, but elsewhere in the Ligonier Valley they are wanting. They are found, as might be expected, in fragmentary areas on the crests of high divides, or capping isolated knobs, which rise far above the surrounding country; and the whole area of the *Pittsburg coal bed* does not exceed three thousand acres. The following section has been compiled from partial sections obtained in the two important areas, one of which lies wholly within Fairfield township, while the other embraces portions of both Ligonier and Fairfield:

1. Limestone,	6″
2. Concealed,	25′
3. Limestone,	2′
4. Concealed,	84′
5. *Brushcliff coal bed ??*	0′ 6″
6. Clay,	3′
7. Fishpot limestone?	6′
8. Shale and shaly sandstone,	28′
9. *Redstone coal bed ??*	0′ 6″
10. Clay,	2′
11. Redstone limestone?	4″ to 10″
12. Black shale,	6′
13. *Coal bed,*	2′ 0″
14. Shale,	17′ to 37′
15. *Pittsburg coal bed,*	8′
Total,	221′ 0″

The Great Limestone is represented only by No. 3, which was seen on the property of Mr. Blair near the southern line of Fairfield township. It occasionally shows an increased thickness and always yields an excellent lime. No. 1 is most probably the Uniontown limestone, though it may

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be part of the Great limestone, for in the southern part of the Blairsville trough that mass shows a tendency to break up into several divisions.

No definite exposure of No. 4 could be found. The whole interval is reached only on the hills at the head of Hanna's run in the northeast area, while the highest hills of the southern areas catch only the lowest 30 feet of it. This interval contains much shale and shaly sandstone, but no traces of either coal or limestone were observed in it.

The existence of the *Sewickley coal bed* is somewhat mythical. It is reported as occurring at Mr. Brenizer's quarry in Ligonier township, but no evidence of its presence could be found at that quarry or at any other place. It is said to be a hard block slate which does not burn well.

The Fishpot limestone (?) was seen only in the southern area, where at nearly two miles north from the borough of Ligonier, it is quarried by Mr. Brenizer. The higher hills in this vicinity catch the bed, but no traces of it were found in the northern area, though the horizon is sufficiently well exposed to exhibit the rock, if it be present. Below this limestone there is a flaggy sandstone interstratified with shale, as is so often the case in the Blairsville trough.

The existence of the *Redstone coal bed* is quite as improbable as is that of the *Sewickley*, the testimony being given by the same person. No signs of the bed could be found anywhere. In the road just north of the Meyer's schoolhouse in Ligonier township some black shale mixed with coal occurs in the clay overlying the limestone, but, as much coal is hauled over this road, the probability is that the coaly material has been dropped by some passing wagon. This is the more probable because at all the localities in this vicinity, where the exposure is complete for eight or ten feet above the *Redstone* limestone, (?) neither coal nor carbonaceous shale is present. In the Final Report for 1858 a thick coal bed is said to occur at this horizon. How such an error could have arisen is difficult to conceive, unless indeed the coal bed, No. 13, was placed both above and below the Redstone limestone; which is not impossible, for one coming from the north might readily make the mis-

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take, as the interval between the limestone and the *Pittsburg coal bed* increases rapidly toward the south. The exposures were very poor at the time the first survey was made, forty years ago. There is no coal bed at this horizon in the northern area in Fairfield township.

The Redstone limestone (?) is a variable rock, which attains its chief importance in Ligonier township, as it becomes quite argillaceous northward. Like the Fishpot it is somewhat ferruginous and on the weathered surface is bright yellow, but in the interior it has a dull flesh color. Some of the layers yield an excellent lime while others are but an inferior cement rock.

The coal bed, No. 13, is the same with that which on p. 46 of *KK* I thought equivalent to the Redstone. For the present it may be regarded as a rider to the *Pittsburg*, similar in its relations, to the lower of the two intercalated beds in the Blairsville trough or to that seen near the Pennsylvania Railroad in the Lisbon trough. No openings were found in this bed, but it is persistent to beyond the southern line of Fairfield township, though in the extreme outlying areas at the north it is wanting or at least unknown.

The interval between the Redstone limestone (?) and the *Pittsburg coal bed* decreases rapidly northward. Near Meyer's school-house in Ligonier township it is nearly 45 feet, while at the southern line of Fairfield township, barely three miles away, it is but 25 feet. At both places the "rider" coal bed is present and the interval between it and the *Pittsburg* is filled with shale.

The only bed of the series which has economical value in the Ligonier Valley is the *Pittsburg coal bed.* Its character and distribution are fully set forth in the descriptions of Fairfield and Ligonier townships, so that only a passing reference is necessary here. Usually the bed is single, but for the most part traces of the roof division so characteristic in the more western troughs are found in an overlying black shale, which frequently contains streaks of coal. The division into benches is quite different from the typical arrangement at the west, though as shown in Report KK, the intimate structure of the bed in the Blairsville trough

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is as it were a transition from that seen in the Ligonier Valley to that which occurs in the Lisbon trough. In the Ligonier Valley the bed varies from 7 to 8 feet and shows three persistent benches. In all, the coal is soft but the middle bench has a loose prismatic structure and its coal is very tender. The composition of the coal is shown by the following analyses:

I. T. S. Seaton, Ligonier T. (A. S. McCreath.)

II. J. McFarland, top bench, Ligonier T. (A. S. McCreath.)

III. Same, middle bench. (A. S. McCreath.)

IV. R. R. Cauffield, Fairfield T. (A. S. McCreath.)

	I.	II.	III.	IV.
Water,	0.580	1.275	1.190	1.050
Volatile comb. matter,	24.850	25.195	26.080	25.170
Fixed carbon,	64.779	65.517	59.789	69.602
Sulphur,	3.496	2.248	3.116	0.668
Ash,	6.295	5.765	9.825	3.510
	100.	100.	100.	100.
Per cent. of coke,	74.570	73.530	72.730	73.780
Color of ash,	Red.	Gray.	Gray.	Red.

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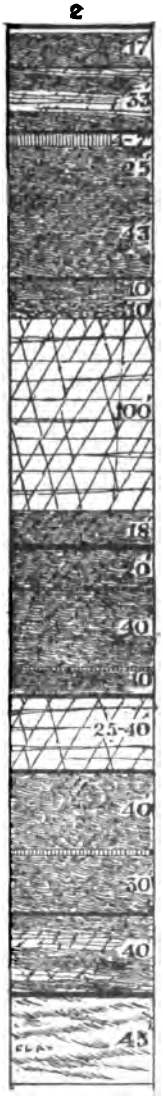
Chapter IV.

The Lower Barren Series.

A generalized section of the Lower Barren Series as it occurs in the Ligonier Valley is approximately as follows:



1. *Pittsburg coal bed,*	
2. Clay,	3′
3. Shale,	17′
4. *Coal bed,*	0 4″
5. Shale and sandstone,	33′
6. *Little Pittsb'g C. B.,*	1′ 6″
7. Little Pittsb'g L. S.,	4′ to 7′
8. Shale,	25′
9. Variegated shale,	43′
10. Coal bed,	1′ 6″
11. Shale,	10′
12. S'dy shale & iron ore,	10′
13. Morgantown S. S.,	100′
14. Shale,	18′
15. *Elk Lick coal bed,*	3′
16. Shale,	20′
17. Green crinoidal L. S.	2′
18. Shale,	40′
19. Ferruginous L. S.,	2′
20. Shale,	10′
21. *Coal bed, Berlin?*	1′
22. Saltsburg sandstone,	25′ to 40′
23. *Coal bed, Platt?*	2′
24. Shale,	40′
25. Black fossiliferous limestone,	3′
26. Variegated shale,	30′
27. *Coal bed, Coleman,*	2′
28. Shale and sandstone,	40′
29. *Philson coal bed,*	2′ to 3′
30. Clay and shale,	45′
Total,	552′ 4″

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In the identification of many of the strata here named, with those of Somerset, east from Laurel ridge and of Fayette and Westmoreland west from Chestnut ridge, there is of course some degree of uncertainty, as those bold axes cut off all connection between the Ligonier Valley and the basins east and west from it. Yet some of the rocks are so thoroughly characteristic as to afford almost exact horizons, from which to work in making identifications of the others.

The most marked difference between this section and the sections given in Reports K and KK is within the first fifty feet below the *Pittsburg*, which in this contains no limestone whatever, whereas in nearly all of those it contains two or more beds of limestone. Exposures of this interval are quite frequent in Ligonier and Fairfield townships of Westmoreland county and they all exhibit the conditions shown by the section.

The *Little Pittsburg coal bed* was seen near Ligonier on the south side of Loyalhanna creek as well as at numerous other localities in the northern portion of Ligonier township. Many years ago, before the existence of the *Pittsburg bed* was suspected, this bed was mined, though it is rarely more than 15 inches thick. It is certainly one of the most persistent beds in the column, being present in every section reported in K and KK, and it has been recognized by the Messrs. Platt in the Salisbury basin of Somerset county. It yields a moderately good coal, but everywhere is too thin to be of economical value.

The limestone underlying this coal bed is equally persistent with the coal itself, as may be seen by referring to the sections in K and KK and it has been fully identified in Somerset county by the Messrs. Platt. Within the Ligonier Valley it is often exposed in Ligonier and Fairfield townships, where it is known as the "50-foot" limestone and is quarried all round the areas of the Upper Productive Coal Series. It is a bluish rock, quite clean and yields a lime far superior to that from any other except the highest limestone above the *Pittsburg coal bed.* Agriculturally its importance is considerable, and land having this limestone ac-

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cessible is held at much higher value than land without it, or having it, without means of access to it.

The Connellsville sandstone, which appears in so many sections west from Chestnut ridge is not present here and its place, almost directly below the Little Pittsburg limestone, is occupied by shale, which is usually argillaceous and reaches quite to the *coal bed*, No. 10. This coal, which many years ago was opened near Ligonier, seems to be persistent, as a bed holding nearly this place occurs in many sections west from Chestnut ridge, while at almost the same distance below the limestone a coal bed of similar thickness has been found by the Messrs. Platt, in the Salisbury basin of Somerset county. At one locality near Ligonier there is said to be a limestone with this coal but no exposure exists there. At another locality where the exposure is complete the limestone is wanting.

An iron ore rests almost directly on the Morgantown sandstone. Reference to it will be made in another chapter.

The Morgantown sandstone does not always show the massive structure so characteristic of it at most localities west from Chestnut ridge. In the southern portion of the Ligonier Valley owing to the pointing out of the basin in that direction, the section seldom reaches high enough to catch this rock and, when it does, the exposure is rarely satisfactory. Near Wharton furnace in Fayette county, this sandstone has been mistaken for the Mahoning as it is massive and, though for the most part fine grained, shows occasional pots of conglomerate. At the furnace it was used both for building and lining the stack and proved well fitted for both purposes. In Westmoreland county near the line of Fayette it is massive and in Donegal and Mount Pleasant townships huge blocks of it are scattered over the hill tops. But northward the massiveness is lost, so that on the Loyalhanna near Ligonier there is at this horizon a great mass of shale and shaly sandstone to represent the sandstone. The lower portion there which is a fine-grained micaceous rock is well exposed in the creek bank at Ligonier and just above the borough it is quarried for use as

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flagging stone. This character is retained northward for some distance but as one approaches the Conemaugh he finds the whole mass breaking down into shale so that the sandstone can no longer be recognized as such.

The *Elk Lick coal bed* has been identified by the Messrs. Platt with that which in the Reports K and KK was called the *Barton coal bed* from its supposed equivalence to a coal bed bearing that name in the Cumberland basin. The detailed examination of Somerset by Mr. W. G. Platt resulted in finally determining the relations of the *Elk Lick coal bed* and showed that it belongs not at the base of the Lower Barrens but midway in the column. As the Morgantown sandstone has been satisfactorily recognized in that county and the *Elk Lick coal bed* underlies it just as the so-called *Barton coal bed* does in the region west from Chestnut ridge, nothing remains but to request those having copies of Reports K and KK to strike out the term "*Barton*" wherever it occurs in those reports and to substitute "*Elk Lick*" therefor. Though no longer mined the *Elk Lick coal* is thoroughly persistent, having been seen at all localities where its horizon is exposed. Its thickness varies from 18 inches to nearly four feet. Formerly this bed was mined near Wharton furnace in Fayette county and near Ligonier in Westmoreland. At the latter locality it was digged out of the Loyalhanna and yielded excellent fuel, as is so often the case with coal, which has been leached by running water.

The Green Fossiliferous or Crinoidal limestone was seen at few but widely separated localities. Within this basin it is for the most part quite argillaceous and for this reason, perhaps, its place is usually concealed. The rock was found *in situ* only on Zimmerman's run in Ligonier township, but its fragments are of common occurrence at many places in Westmoreland county. In Fayette county it was not found in place and its fragments were seen only near Wharton furnace. Below this limestone to the Saltsburg sandstone there is usually only variegated shale, but on Dunbar creek in Fayette and on Four-mile run in Westmoreland a *thin coal bed* was found near the base of the interval, and it is

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given in the general section as possibly the equivalent of the *Berlin coal bed* of Somerset county.

The Saltsburg sandstone is so named in accordance with the suggestion of Professor Lesley, because it is finely exhibited along the Conemaugh and Loyalhanna near Saltsburg, as mentioned in Report KK, *p.* 317. This rock is well shown in Henry Clay, Stewart and Springfield townships of Fayette, in all of which it is a massive rock, 40 to 50 feet thick, gray and for the most part coarsely conglomerate, the pebbles being as large as peas. Some portions of it disintegrate readily and, where they occur, the soil is loaded with pebbles, as is the case near the village of Springfield. At most localities, however, it resists weathering and huge blocks of it cover the hill-sides in Stewart township, so as to render the surface unfit for cultivation. This is the conglomerate which is described in report KK p. 184 as occurring on Dunbar creek at the west base of Chestnut ridge. During the past season, I identified with this the coarse sandstone on the National road at the base of the ridge in North Union township. Along Four-mile run, in Cook and Ligonier townships of Westmoreland, this rock is as coarse as in any portion of Fayette county, but along the Loyalhanna in the same townships it is comparatively fine-grained and shows no conglomerate. Northward from the Loyalhanna it is no longer a conglomerate and on the Bedford pike, east from Ligonier, it is quarried as a building stone. It retains this character northward to the Conemaugh river.

The interval between this rock and the Black Fossiliferous limestone is concealed or at least imperfectly exposed in the southern portion of the valley, but such exposures as do occur show the interval to be occupied for the most part by shale. In Westmoreland county at several localities where the exposure is complete, shales alone occur.

The Black Fossiliferous Limestone being associated with characteristic black shales was more frequently seen than the Crinoidal limestone. In the extreme southern part of the valley it is a poor clayey rock, more or less nodular and always very dark; frequently it is wholly replaced by dark

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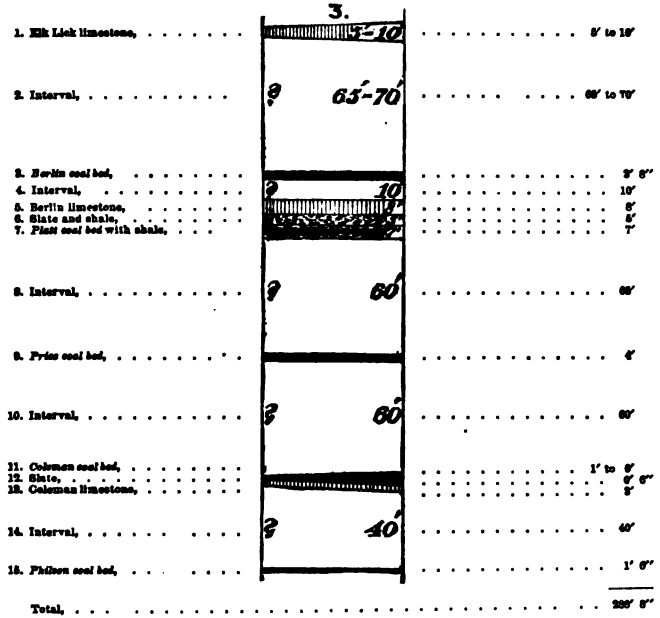
calcareous shale. Further north it is richer in lime and at some localities it is good enough to be burned for lime, but near the Conemaugh it again becomes thin and almost worthless. Along the base of Laurel ridge in northern Westmoreland it is an iron ore and as such it was mined to a considerable extent; but this peculiarity disappears southward, for in Donegal township along Indian creek it is a limestone. At all localities it is richly fossiliferous.

The interval between the Crinoidal limestone, and the *Philson coal bed* is not fully exposed at any locality, and the details gathered at the many fragmentary exposures show such inconsistencies, that to make even an approximately accurate generalized section, is almost impossible. For the same reason, some difficulty is found in determining the relations of these rocks in the Ligonier Valley, to those occupying the same interval in Somerset county, where Mr. Platt has succeeded in working out the general structure most admirably. For the sake of making the comparison, I reproduce this portion of Mr. Platt's section:


3.
1. Elk Lick limestone, ... 5'-10' . . . . . 5' to 10'
2. Interval, ... 65'-70' . . . . . 65' to 70'
3. Berlin coal bed, ... 2' 6"
4. Interval, ... 10' . . . . . 10'
5. Berlin limestone, ... 2' . . . . . 2'
6. Slate and shale, ... 5' . . . . . 5'
7. Plain coal bed with shale, . . . 2' . . . . . 1'
8. Interval, ... 60' . . . . . 60'
9. Price coal bed, ... 4'
10. Interval, ... 60' . . . . . 60'
11. Coleman coal bed, ... 1' to 2'
12. Slate, ... 2' 6"
13. Coleman limestone, ... 2'
14. Interval, ... 40' . . . . . 40'
15. Philson coal bed, ... 1' 6"
Total, ... 220' 6"

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Here I take the Elk Lick limestone to be practically the same with the Crinoidal limestone, for, although the two rocks differ very materially in physical characters, yet the section shows that they hold very nearly, if not identically, the same relation to the *Elk Lick coal bed*, which, by common consent, is regarded as the same with the *Barton coal bed* of my previous reports. At the same time, I would not be understood as asserting positively that these limestones are the same bed, though, as the Crinoidal limestone is unknown in Somerset county, and, as it is the first limestone below the *Elk Lick coal*, in the Ligonier and Blairsville troughs, I think that the probabilities are all in favor of the supposition that Elk Lick limestone and Crinoidal limestone are synonymous terms. If the relation of the Black Fossiliferous limestone to any of the beds given in the section had been made out in Somerset county, there would have been less room for uncertainty in the attempt to make out the connection between the two counties. In Somerset, the interval represented by the section just given, is not far from 275 feet, while in the Ligonier Valley no measurement shows it to be more than 225 feet, and in several it is considerably less.

The coal bed between the Crinoidal limestone and the Saltsburg sandstone, was seen on Four-mile run, in Westmoreland, and on Dunbar creek, in Fayette, and is very thin at both localities. On the Tub-mill run, in Fairfield township, and on Mill creek, in Ligonier township, of Westmoreland, as well as on the Pennsylvania Railroad, west from Larimer station, a coal bed was seen at from 40 to 50 feet above the Black Fossiliferous limestone, which, in all probability, represents the *Platt coal* of Somerset. It is very thin, and has no economical value. This may be the bed seen on the National road, west from Farmington, and on the road leading from Ohiopyle Falls to the mouth of Jonathan's run, in Fayette county.

At three to five feet below the Black Fossiliferous limestone, there is frequently a thin coal bed associated with a worthless iron ore. Possibly this may represent the *Price coal bed* of Somerset. Another coal bed, which is given in

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the general section as the *Coleman*, occurs about midway between the Black limestone and the *Philson coal bed.* A bed holding a similar position was seen on Indian creek, in Donegal township, of Westmoreland; as well as near Springfield, and on the National road, in Fayette county. It is too thin to be of any value whatever.

This whole interval has more or less variegated shale. Such shale always occurs with the Crinoidal limestone, and continues almost to the Saltsburg sandstone. Similar shales are found with the Black limestone, but they are not so brilliant as those belonging to the upper horizon.

The Philson coal bed. With this Somerset county bed I have identified throughout the district the first bed above the Mahoning sandstone, which is from 40 to 80 or 90 feet above the *Upper Freeport coal bed.* The variation in the interval depends largely upon the presence or absence of shale between the coal bed and the Mahoning sandstone.

On the National road in Wharton township of Fayette, this bed is exposed near Farmington, where it is 2 feet thick, and is separated from the Mahoning sandstone by 20 feet of shale. No coal bed intervenes between it and the sandstone, and no limestone accompanies it. In Stewart township the coal is 3 feet thick, and is 65 feet above the *Upper Freeport.* In Springfield township on Laurel Hill run, the bed is 5 feet thick; rests directly on the Mahoning sandstone, and is 50 feet above the *Upper Freeport*, while at Springfield it is 3 feet thick, and 45 feet above the other bed, but on Indian creek, at a short distance above the village, the interval is 55 feet.

In Cook and Donegal townships no direct measurement could be obtained, but on the Loyalhanna, east from Ligonier, the interval is about 80 feet, with much shale between the coal bed and the sandstone. There the coal bed is but one foot thick. On the Pennsylvania Railroad, the interval to the *Upper Freeport coal bed* is about 90 feet, and the shale below the coal to the Mahoning sandstone, is from 25 to 35 feet thick. On the east side of the valley, the railroad sections show a limestone below the *Philson coal bed,* but no such rock is present on the west side.

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In the Fayette and Westmoreland district, the first bed above the Mahoning sandstone, is separated from that sandstone by from one to thirty-five feet of shale. This first bed, I have identified with the *Philson*. It is of no economical importance.

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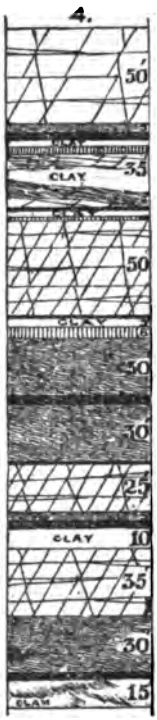
Chapter V.

The Lower Productive Coal Series.

The rocks of this series are readily accessible along both sides of the Ligonier Valley within Westmoreland county and along all the principal streams within Fayette county. A generalized section is as follows:



1. Mahoning sandstone,	50′
2. Shale,	8′
3. *Upper Freeport coal bed*,	4′
4. Clay,	2′
5. Upper Freeport limestone,	4′
6. Shale clay and sandstone,	35′
7. *Lower Freeport coal bed*,	2′
8. Clay,	2′
9. Lower Freeport limestone,	2′
10. Lower Freeport sandstone,	50′
11. *Upper Kittanning coal bed*,	1′
12. Clay,	2′
13 Upper Kittanning limestone,	6′
14. Shale,	50′
15. *Lower Kittanning coal bed*,	4′
16. Shale,	30′
17. *Coal bed B*,	1′
18. Bolivar sandstone,	25′
19. Shale,	3′
20. *Clarion coal bed*,	4′
21. Clay,	10′
22. Clarion sandstone,	35′
23. Shale,	60′
24. *Brookville coal bed*,	3′
25. Clay and shale,	15′
Total of section,	389′

The Mahoning Sandstone.

This important rock is present within the Ligonier Valley at all localities where its horizon is reached. In no inconsiderable part of the district the sandstone is single, from 40 to 60 feet thick, varying from coarse to fine grained,

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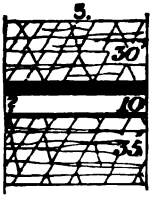
sometimes massive, at others flaggy, while again it is a mere agglomeration of shale and shaly sandstone. When massive, as in Fayette county, and the hills are high enough to catch also the Saltsburg sandstone, the debris from the two rocks renders the surface totally worthless for agricultural purposes.

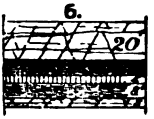
But in a large portion of the district the sandstone is double, the divisions being separated by a variable interval containing coal, shale and sometimes limestone. In Stewart township, north from Ohiopyle Falls a section shows:



1. Sandstone,	30′
2. *Coal*,	7′
3. Concealed,	10′
4. Limest'e and iron ore,	2′
5. Sandstone,	35′
Total,	84′

The sandstone layers are precisely alike, being gray, comparatively soft and quite fine grained. The coal bed is double, the benches being equal and separated by one foot of clay; but it yields poor fuel and perhaps it may better be called a rich carbonaceous shale. The limestone and ore of this section are very widely distributed, the ore being the same with that mined at the Springfield mines below Indian creek on the Youghiogheny. The same bed occurs in Stewart township south from the river. It is the Johnstown ore. As already intimated the intermediate rocks disappear before reaching the National road so that there the two sandstones come together and the thickness is somewhat less than the aggregate given in the section.

Northward from this, the rock appears to be single along the east face of Chestnut ridge, except in Mount Pleasant township of Westmoreland, where the following section was obtained:



1. Sandstone,	20′
2. *Coal* bed,	3′
3. Shale,	2′
4. Iron ore,	0′ 8″
5. Shale,	2′
6. Ferruginous limestone,	4′
7. Shale,	6′
8. Sandstone,	6′
Total,	44′ 8″

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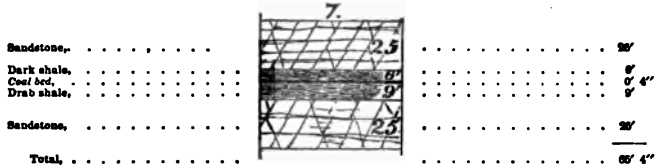
In Fairfield and St. Clair townships of Westmoreland the same structure was observed, the limestone however being absent. The following section was obtained on Laurel Hill run in the latter township:



This character seems to be persistent along the face of Laurel ridge southward almost to the line of Ligonier township, but northward it disappears within two or three miles so that on the Conemaugh the sandstone is single. The dark shale of the section contains a considerable percentage of iron but not enough to make it valuable, as was ascertained by an expensive and unprofitable experiment at Laurel Hill furnace.

A variable shale comes between this sandstone and the *Upper Freeport coal bed.* It occasionally becomes 20 feet thick but at many localities it is wanting and the sandstone rests directly on the coal. But no instances of erosion were observed and the sandstone forms a very regular roof.

The Upper Freeport Coal Bed.

This, the great coal bed of the Lower Productive Coal Series, is reached within every township of the Ligonier Valley. At the north, within Westmoreland county, the accessible area is small, being confined to narrow strips along the base of the mountains, but southward in Fayette, the steady rise of the basin in that direction brings the coal nearer to the surface, so that it is readily accessible, not only along the bases of the mountains, but also along the irregular valleys through which the larger streams flow. The bed is usually double, sometimes triple, though at a few localities it is apparently single. The changes in thickness and structure are abrupt.

Along the Youghiogheny river in the extreme southeast corner of Fayette, the bed seems to be single, and at most

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localities it has only knife-edge partings, but occasionally, as on the river at two or three miles below the National road, the upper division of the bed is seen.

In the southwest corner of the valley, south from the National road, the bed is almost invariably double, both divisions showing only very thin partings, but occasionally on both Big and Little Sandy it is broken up in a complex manner; at one opening on Grosses run, a tributary to Big Sandy, the total thickness of the bed is 9 feet 7 inches, the upper division being represented by fourteen layers of coal and shale, in all 6 feet 9 inches. The clay partings are thin, but suffice to injure the coal badly. A similar structure occurs on the Little Sandy near Shinbone Alley.

Following Meadow run down to the Youghiogheny river one finds the bed always double, but hardly holding its own in thickness, for near the National road it has from four feet to four feet, six inches of coal, while near the river it is rarely thicker than 3 feet 6 inches, including the partings, and along the south side of the Youghiogheny it becomes insignificant, showing barely two feet at one exposure.

Northward from the Youghiogheny, the deep gash eroded by Indian creek affords ample exposures, and shows the bed always double, with the upper division parted, as seen in a section obtained north from Ohiopyle Falls, thus:

Upper division,	2′ 10″
Coal,	1′ 7″
Coal,	1′ 3″
Clay parting,	1′
Lower division,	2′ 11″
Total,	6′ 9″

But the parting in the upper division rarely contains any clay. The top bench is usually slaty, while the lower one is often prismatic. Ordinarily the lower division is broken by numerous thin binders of clay, soot or pyrites. The structure given in this section prevails within Fayette county northward from the Youghiogheny river, though of course there is much variation in the thickness of the benches; thus along Indian creek the lower division is

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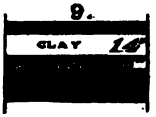
sometimes not more than 18 inches and the clay parting barely 4 inches, making the thickness less than 4 feet.

But even along this line, where, in the great majority of the pits, the bed shows remarkable regularity, there are abrupt changes. On Fayette furnace property the thickness varies from four to seven feet within a couple of yards, and the change occurs indifferently in the upper or the lower division. On Indian creek, about two miles from Springfield, the bed is a mass of clay, carbonaceous shale and slaty coal, not less than 12 feet thick; while within stone's throw in all directions it shows its normal character.

Along the base of Laurel hill in Westmoreland county the bed is so degraded as to be of little value. Near the head waters of Indian creek it shows:



Coal,	8″
Clay,	14″
Hard shale,	8″
Coal,	20″
Total,	4′

Further north, at the head waters of the Loyalhanna, it is in one bench and varies from 3 feet 6 inches to 4 feet. Along the Loyalhanna to the Bedford pike it is little more than 3 feet, though sometimes becoming 4, and is less important than the *Lower Kittanning*. Near the pike it has three feet of coal with a parting at one foot from the bottom. Still further north on Tub-mill run, it has somewhat more than 4 feet of coal, but thence to the railroad it becomes less, being only 2 feet 6 inches on Laurel Hill run and 2 feet 3 inches on the Pennsylvania Railroad. The variations here are curious; thus, as far north as Tub-mill the lower division alone appears to be present; on Laurel Hill run, only the upper; while on the railroad, notwithstanding the great decrease in thickness, both divisions are clearly present.

Along the base of Chestnut ridge in Westmoreland county the *Upper Freeport coal bed* is much thicker than on the opposite side of the valley. At an opening in Mount Pleasant township the upper division shows:

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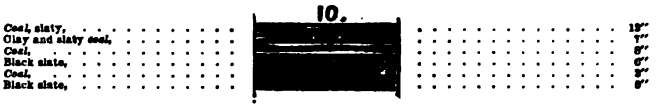
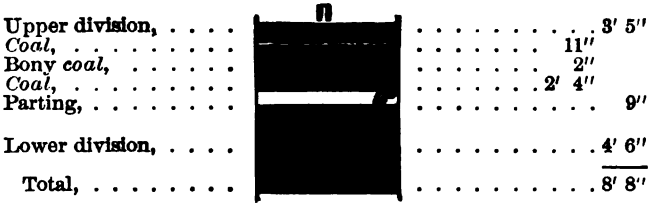


The main parting being 4 inches of ferruginous clay, and the lower division 3 feet in three almost equal benches. In Ligonier the whole bed is from 5 to 7 feet thick, with the upper division double and separated from the lower by 11 inches of clay containing streaks of coal. On Tub-mill run in Fairfield township the structure is:



But on the Pennsylvania Railroad in the same township, the upper division is 5 feet, the clay parting, 2 inches and the lower division only 2 feet 3 inches. At all localities the coal of the upper division is brilliant, in very thin layers separated by still thinner layers of hard black clay. The lower division has a dull lustre, is much broken by binders and most of its coal comes down in slack.

For the most part the coal from this bed is soft and no pit was found which yields a good shipping coal. As fuel it is fairly well liked, but wherever the *Pittsburg coal* can be obtained, that is preferred, even though, as on the National road, it has to be hauled for a distance of ten or twelve miles. It is almost invariably too sulphurous to be used in making coke, even were it not rendered worthless for that purpose by the numerous thin slates, which increase the percentage of ash far beyond what is shown by the analysis. The quality of the coal is clearly so poor that it was thought unnecessary to have a full series of analyses made, and specimens were taken from a few widely separated localities simply to illustrate the prevailing character of the coal. The results of these analyses are given in another chapter.

Between this coal bed and the Upper Freeport limestone,

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there is usually a clay and sometimes a sandstone, but the latter is not commonly found. The clay is occasionally non-plastic, but it is not thought to be valuable.

THE UPPER FREEPORT LIMESTONE.

This, which in the Final Report of 1858, is termed the Freeport limestone, is not wholly persistent though it is present at a large proportion of the localities where its horizon is exposed. It occurs at from 5 to 15 feet below the coal and varies from zero to 18 feet in thickness. In Henry Clay township it is present on both sides of Laurel ridge; in Wharton township it is more than 10 feet thick near the State line on Big Sandy, but is wholly wanting near Wharton furnace and on the National road. Along Meadow run and throughout western Stewart it is persistent, is 6 feet thick on Meadow run, 18 feet on the river hill above the mouth of Jonathan's run and only 3 feet at the northern edge of the township. North from the Youghiogheny it is irregular, being 9 feet near Ohiopyle, 3 to 5 feet near Springfield, but of uncertain occurrence near Fayette furnace. North from Springfield it is present to the county line, but thence along Indian creek in Westmoreland county it seems to be unknown.

Following up the base of Chestnut ridge one finds this limestone fully 10 feet thick in Mount Pleasant township, 11 feet in on Four-mile run and of unascertained thickness on the Loyalhanna, but on Tub-mill run in Fairfield township it is clearly wanting, while on the Pennsylvania Railroad in the same township it varies from zero to 10 feet. Along the base of Laurel ridge, this limestone appears to be absent or nearly so south from the Bedford pike, but at the pike some fragments of it were seen. On Hendrick's run it is 11 feet thick; on Tub-mill it is 14 feet, but only 3 feet 6 inches on Laurel Hill run while on the Pennsylvania Railroad it is wanting.

This rock varies quite as much in quality as it does in thickness. At most localities it has on top a thin layer of dark blue impure slaty limestone, which is worthless, while the remaining portion is dull bluish gray with irregular

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fracture and more or less argillaceous. When burned hastily, it is apt to fuse, but if burned slowly it yields a lime, which does well for agricultural purposes, for which use it is highly valued. Oftentimes it is quite ferruginous at the outcrop and it was mined as an iron ore at Laurel Hill furnace. At some localities in Fayette it has been mistaken for iron ore and at the head of Jacob's creek a lean ore is associated with it.

The Upper Freeport Fireclay.

This non-plastic clay is well known as the Bolivar fireclay and in former times it had a high reputation. It is widely distributed but is not so persistent that one would be justified in expecting to find it at all localities where its horizon is reached. The typical locality is at Bolivar at the east end of the Conemaugh gap through Chestnut ridge, where it occurs immediately below the place of the Upper Freeport limestone. There a somewhat similar clay sometimes appears directly below the *Freeport coal bed.* The name however belongs to the more persistent bed below the limestone.

In Wharton township of Fayette this clay is exposed in the road near Wharton furnace, where it is 10 feet thick, light blue and contains many nodules of clay iron-stone. This is its character throughout the township. In Stewart it seems to be fully persistent and is 8 feet thick along the river hills where it contains huge balls of iron ore. On Indian creek in Springfield township it is but 4 feet thick.

In Westmoreland county it was seen at but few localities south from the Bedford pike, and where it was seen the exposures are not such as to admit of measurement. On Laurel run of Ligonier township it is 2 feet thick. North from the Loyalhanna it was not observed along the east side of the valley, but on the west side it is persistent from the southern boundary of Fairfield township to the Conemaugh river.

The clay is subject to annoying variations. At Bolivar it is embedded in a mass of shale and varies from 3 to 12 feet. Often it is cut out by plastic clay or by ordinary shale,

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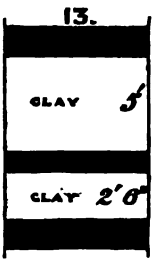
while at one place it ends abruptly against a wall of hard sandstone. The quality seems to be quite stable. The results of analyses will be given in another chapter.

The Lower Freeport Coal Bed.

In Wharton and Henry Clay townships the horizon of this bed is usually concealed, but in the latter township it was seen at one locality on Little Sandy where it is 4 feet thick and yields good coal. In Stewart township it seems to be present everywhere and, though subject to great variations in thickness, it is an important source of supply. On Meadow run this bed varies from one to 5 feet but is of little value, for when thick it is so badly broken by slates that the coal is worthless, whereas along the Youghiogheny between Ohiopyle Falls and the mouth of Jonathan's run it is important. One opening shows:

Coal,	2′ 3″
Clay,	4″
Coal,	3 4″
Total,	5′ 11″

While at another barely half a mile away the section is:



Coal,	1′ 6″
Clay,	5′
Coal,	1′
Clay,	2′ 6″
Coal,	1′ 6″
Total,	11′ 6″

Northward from the Youghiogheny river it becomes unimportant and rarely exceeds 1 foot 6 inches in Fayette county; but in Mount Pleasant township of Westmoreland it is 3 feet 6 inches on the clay pike, while in Ligonier township of the same county it is only 6 inches thick near Laughlinstown. In Fairfield township on the west side of the syn-

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clinal it is 17 inches on Tub-mill run, but on the Pennsylvania Railroad within the same township it shows:

Coal,	1′ 8″
Clay,	3″
Coal,	9″
Total,	2′ 8″

At this exposure, which is near the eastern side of Fairfield, the coal is much distorted and the bed suffered much from erosion during the formation of the overlying shale. On the east side of the valley, within St. Clair township, only the blossom of the bed was seen.

Below the *Lower Freeport coal bed* there is a fireclay, but it is unimportant.

The Interval Between the Freeport Coal Beds.

The variations of this interval cannot be reduced to accord with any system. Thus in Stewart township of Fayette it is 28 feet on Meadow run, while on the river hill it is 74 feet; and a curious feature is that at the latter locality a thin coal bed holds a relation to the *Upper Freeport* similar to that held by the *Lower Freeport* on Meadow run, yet the presence of the great Lower Freeport sandstone at both localities shows that the little coal on the river hill is not the same with that observed on Meadow run. In the Youghiogheny gap through Chestnut ridge the interval is 85 feet and in Springfield township it is 60 feet. In Mt. Pleasant of Westmoreland it is 40 feet, in Ligonier township 62 feet, on the Pennsylvania Railroad in Fairfield, 39 feet, but on Tub-mill run in the same township it is 93 feet and a thin coal bed occurs at 8 feet below the *Upper Freeport*. In St. Clair it is 22 feet on Powder Mill run, 33 feet in the Conemaugh gap, and 20 feet in the oil-boring below New Florence. In this interval there is no sandstone sufficiently persistent to be identified with the Upper Freeport sandstone of the western counties and all the strata are characterized by extreme variability.

THE LOWER FREEPORT LIMESTONE.

This hardly deserves a place here, but, as it seems to be a persistent stratum in some of the other districts and as I

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observed it at three localities, it is given in the section. On the Connellsville railroad near the west end of the Youghiogheny gap through Chestnut ridge, it is 4 feet below the coal and is 2 feet thick. On Tub-mill run in Fairfield township of Westmoreland it is 6 feet below the coal, 3 feet thick and somewhat ferruginous. On the railroad in the same township it is ferruginous, 2 to 4 feet thick and 3 feet below the coal. At each locality it is irregular and changes to calcareous nodules. This limestone is said to be present in St. Clair of Westmoreland but no evidence of its presence could be found at any locality along the face of Laurel ridge.

The Lower Freeport Sandstone.

In a large part of the Ligonier Valley the Lower Freeport limestone is wanting, and the coal bed is separated from this sandstone by only a thin bed of impure fireclay. In Wharton township of Fayette the sandstone is shown on Little Sandy, where it is a massive rock whose fragments cover the broad "bottom" of the stream. In Stewart township it is distinct on Beaver run, Meadow run and along the Youghiogheny, on all of which forms bold cliffs, which run almost unbroken around the hills. The rock is from 40 to 50 feet thick, quite compact above, becoming flaggy below and toward the base contorted by vast numbers of rude vegetable impressions. For the most part it is comparatively fine-grained sandstone and the more compact portions are excellent for building.

Northward from the Youghiogheny, the rock is flaggy and near Bear run it is exposed in a cliff, 65 feet high. Beyond the line of Springfield township this sandstone seems to be of very uncertain occurrence. At some places it has disappeared, as at near Laughlinstown in Ligonier township of Westmoreland county, where the interval between the *Lower Freeport* and the *Upper Kittanning coal bed* is reduced to the minimum, being only 18 feet, and is filled with shale. On the Pennsylvania Railroad within Fairfield township this is represented by 35 feet of sandstone and shale, while on the Tub-mill run the sandstone is wanting and its

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place is occupied by dark shale. In St. Clair the sandstone is wholly wanting.

THE UPPER KITTANNING COAL BED.

This which is supposed to be the equivalent of the Darlington cannel and the Ohio "Strip Vein," was seen at several localities in Westmoreland county, but no traces of it could be found at any exposure along Indian creek or southward so that in all probability it is wholly unrepresented in Fayette county and does not extend south beyond the boundary of Cook township of Westmoreland county.

On Loyalhanna creek and its tributaries, this bed is fairly persistent along the face of Laurel ridge, but for the most part is very thin, being thickest near Laughlinstown where it is 1 foot 8 inches. It is absent from the railroad section in Fairfield township but on Tub-mill run in the same township it is 18 inches thick. In St. Clair township it was seen on Powder mill and Laurel hill runs where it is nearly 5 feet thick and is mined.

The interval between this and the *Lower Freeport coal bed* as shown by the several measurements varies quite as materially as does that between the two *Freeports*. On Laurel run in Ligonier it is 18 feet, on Tub-mill in Fairfield, 54 feet, while in St. Clair township it is 28 feet.

THE UPPER KITTANNING LIMESTONE.

This is the Johnstown Cement bed, which in the Final Report of 1858, was identified with the Ferriferous limestone of the western counties. It is confined to the northern portion of the district and is one of the most uncertain members of the whole column, as it cannot be depended on beyond the range of vision.

The most southern locality at which the bed was seen is on Laurel run in Springfield township of Fayette. There, at somewhat more than a mile above Fayette furnace, it is not far from 8 feet thick, but at the furnace it is wanting and in its stead there is a brownish ferriferous shale. The shale prevails at this horizon everywhere in the vicinity ex-

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cept for a little distance along Indian creek near Springfield, where the limestone again appears.

Along the east face of Chestnut ridge this horizon is rarely exposed and no evidence of the presence or absence of the limestone was obtained until near the Conemaugh, where the rock is present as a hard, thin limestone, weathering very light blue and having no economic importance. Along the base of Laurel ridge it occurs with less irregularity having been seen on Indian creek in Donegal, on the Felger road between Donegal and Cook, on White Oak run in Cook, but in this township it is absent from Powder Mill run, where its place is held by the ferriferous shale; in Ligonier it is absent from Linn's run and Furnace run but is present on Laurel run. Between the last two it alternately appears and disappears, while on Laurel run it disappears abruptly at barely two miles above Laughlinstown. Northward from this line it was not seen and it seems to be absent from Fairfield and St. Clair townships.

This limestone is of much importance notwithstanding the irregularity of its occurrence. It is burned to supply lime for agricultural purposes, but, as it is often quite argillaceous, the burning must be carefully performed or much cinder will be produced. A curious feature of this rock on Laurel run of Ligonier township is the presence of many fragments of a limestone, which clearly belongs to one layer of the Mountain limestone of the Umbral.

In the shale replacing the limestone so much nodular ore is present that at one time it was digged in Ligonier township of Westmoreland and Springfield township of Fayette. The ore is apparently good, but the quantity is insufficient to be of any importance now. The times have changed, so that furnaces making only two or three tons of metal each day can no longer be made profitable.

The Lower Kittanning Coal Bed.

In southern Fayette county the interval between the Lower Freeport sandstone and this coal bed has practically disappeared, so that in many places the sandstone and the coal are in contact, though usually a thin bed of shale in-

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tervenes. The *Lower Kittanning* of the section, which is accepted as the equivalent of the *Kittanning* of the Final Report of 1858, seems to be persistent throughout the district except in St. Clair township of Westmoreland county.

In Fayette county this bed was seen in Wharton township on the Little Sandy, on Cheney run near Wharton furnace and on Big Sandy near Fayette springs. In each instance it is separated from the sandstone above by a shale which becomes carbonaceous toward the base, and has many nodules of carbonate of iron. The coal bed varies from 2 feet 6 inches to nearly 6 feet and has a layer of compact carbonaceous shale as the top bench. The coal is said to be good. In Stewart township, however, it is for the most part a mass of hard carbonaceous shale with usually about 6 inches of coal at the base. At one locality on Beaver run it is a confused agglomeration of coal, shale, sandstone and iron ore, which is totally worthless. In Springfield township it is better and sometimes yields a very fair coal.

In Westmoreland county it was not seen along the face of Chestnut ridge, but it is of much economical importance along the base of Laurel ridge, where it is thicker and better than the *Upper Freeport* and is the chief source of supply for the country south from the Bedford pike. On Indian creek in Donegal township it is 4 feet thick but is not mined; on White Oak and the several tributaries to the Loyalhanna in Cook and Ligonier townships it varies from 3 feet 6 inches to 4 feet and is mined at many places. In all the pits the bed has a slaty layer on top and an obscure parting near the middle. Above the parting the coal is quite hard, but below, it is soft and often shows a prismatic structure. The whole bed yields a very fair fuel, but the proportion of ash is considerable and there is enough sulphur to cause annoyance. The bed is wanting in St. Clair township of Westmoreland and in Fairfield township it is very thin.

Below the *Lower Kittanning coal bed* there is usually a plastic clay, 5 to 7 feet thick, under which, in Ligonier and Cook townships of Westmoreland county, there is a grit, 3 feet thick, made up of matted stems, around which some

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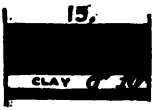
carbonaceous matter sometimes occurs. This rock is almost flint-like in its toughness and at some localities it has been mistaken for a bed of iron ore. It seems to hold the place of the Lower Kittanning limestone, the Ferriferous of the old reports, which otherwise is wholly unrepresented in this valley.

Coal Bed B[1].

At a few localities a coal bed or a richly carbonaceous shale was found at from 25 to 35 feet below the *Lower Kittanning coal bed* and resting on or near the Bolivar sandstone. This bed has been mined by stripping near Wharton furnace in Wharton township of Fayette county, where it shows:



Coal,	2′ 6″
Clay,	6″ to 10″
Coal,	6″
Total,	3′ 8″

One of the thin beds seen on Camp run in Donegal township of Westmoreland may represent this. On Linn's run and Furnace run in Ligonier this bed is only carbonaceous shale. It was not observed elsewhere, but this fact is no evidence against its existence, for, underlying, soft shale and resting on a massive sandstone, it is especially liable to be concealed.

The Bolivar Sandstone.

This important rock is persistent. On Meadow run in Stewart township of Fayette it varies much in thickness at the expense of the shale between it and the *Clarion coal bed*. Here, as on Beaver run and the river it is a massive rock, which resists the action of the weather admirably. Further north in Springfield township of the same county it is not easily recognized as its fragments, scattered over the hillsides, are mingled with those of the Clarion sandstone below. The same difficulty was experienced in Cook and Donegal townships of Westmoreland, where those rocks cover the hills with their debris and effectually conceal all the lower rocks. In Ligonier the Bolivar sandstone

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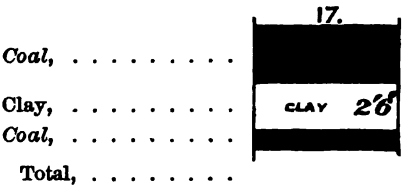
is well shown on Linn's, Furnace and Laurel runs as well as on the Bedford pike, while at Bolivar on the Conemaugh it forms an imposing cliff alongside of Tub-mill run and goes under that stream at barely one third of a mile from the river.

The Clarion Coal Bed.

This bed is usually of sufficient thickness to be of economical importance, but its position between the two great sandstones prevents it from being exposed except at a few localities. In Wharton and Henry Clay townships of Fayette its place is always concealed, but in Stewart its blossom is often shown in the deep channel-ways, through which the streams flow to reach the Youghiogheny river. On Beaver run an opening near the township line shows:

While on Meadow run, but a short distance away, the bed is 3 feet 6 inches thick, without any clay partings; but on the peninsula at Ohiopyle Falls it shows:



And on Bear run it is a single bed barely 2 feet thick.

In northern Fayette the bed was not seen, there being no exposure showing anything below the Bolivar sandstone, but near the head of Indian creek in Donegal township of Westmoreland it is mined and has 5 feet 5 inches of coal without any clays. Further north on Linn's run it is one foot thick, on Furnace run it is from 4 to 5 feet, while on Laurel run of Ligonier it shows:

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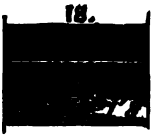


Coal,	1′ 10″
Clay,	2″
Coal,	1′ 6″
Carbonaceous shale,	1′ 8″
Total,	5′ 2″

And the coal is very poor.

At Bolivar it is 1 foot 6 inches but in the Conemaugh gap through Laurel ridge it is concealed.

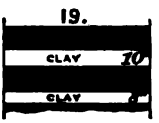
Below this coal bed there is a fireclay, which seems to be good at nearly all localities where it is exposed. At Bolivar it is used in the manufacture of firebrick.

The Clarion Sandstone.

This rock is usually present between the *Clarion* and *Brookville coal beds*. It is one of the most persistent members of the series and rarely shows any tendency to break down into shale. It is the same with that which in Report KK, I very hesitatingly identified with the Piedmont sandstone.

The Brookville Coal Bed.

The blossom of this bed was seen at many places but the bed itself is rarely exposed so as to admit of measurement. It was once mined near Falls City on the Youghiogheny, where it is said to be 4 feet thick. It is mined on Furnace run in Ligonier township of Westmoreland where it shows :



Coal,	1′ 2″
Clay,	10″
Coal,	1′ 3″
Clay,	8″
Coal,	?″

And the same bed is mined near the top of Chestnut ridge in the same township, where it is nearly 5 feet thick. In Report KK this bed was very hesitatingly identified with the *Mount Savage coal bed.*

Between the *Brookville coal bed* and the Pottsville conglomerate there is usually a fireclay which is sometimes replaced by shale.

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Chapter VI.

The Pottsville (Seral) Conglomerate.

This rock is exposed on the sides of both mountain ridges, and along the whole gorge of the Youghiogheny river within the Ligonier Valley. In the southern portion of this valley, it shows some peculiarities not observed on the western side of Chestnut ridge.

The general section of the Pottsville conglomerate, as shown near the Youghiogheny river, is as follows:

1. Piedmont sandstone.
2. Shale.
3. *Mount Savage coal bed.*
4. Shale.
5. Conglomerate

The distinction between the Piedmont sandstone and the conglomerate below the coal bed, is clear only in the southern portion of the valley, near the Youghiogheny river. Northward from that river, the coal bed, and its associated shales soon disappear; and permit the two sandstones to come together. The same condition exists at the west, for, on crossing Chestnut ridge, the two sandstones are so united that they can hardly be distinguished. In this way arose the error of identification into which I was led, whereby the *Brookville coal bed*, or *Coal bed A*, was hesitatingly identified with the *Mount Savage*, and the Clarion sandstone was in like manner identified with the Piedmont. Both of these identifications are without foundation, and those who possess Report KK. are requested to erase those terms from that report, wherever they occur, and to substitute therefor the names *Brookville coal bed* and Clarion sandstone. The name of the Mount Savage (?) Ore Group must be changed to Brookville Ore Group.

In Fayette county south from the Youghiogheny river,

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the Piedmont sandstone is sufficiently distinct, and at many places it is much coarser than the rest of the mass. In the bed of the Youghiogheny at Ohiopyle Falls it is quite coarse and shows pebbles larger than a pea. On the National road at somewhat more than a mile from the summit of Chestnut ridge it is exposed as a comparatively fine-grained and very white sandstone, which evidently would be well fitted for the manufacture of glass-sand. The weathered surface has a peculiarly white to grayish-white appearance, which seems to be more or less characteristic of the rock everywhere along the base of Chestnut ridge, where it is also much finer in grain than it is on the opposite side of the valley.

Followed northward, this rock becomes more and more difficult to distinguish from the conglomerate below. As stated, the *Mount Savage coal bed* and its shales disappear so that the sandstones come together. As the rocks are almost exactly alike, there is no means of distinguishing them and, in the thinning out of the whole mass along the west face of Chestnut ridge, one cannot determine which portion has disappeared.

The *Mount Savage coal bed* seems to exist only in Stewart and Wharton townships of Fayette county. At Wharton furnace in the township of the same name it is said to be 4 feet thick. At one time it was mined somewhat extensively there, as three openings were seen, but all had been deserted for many years and no access to the bed was possible. It evidently yielded inferior coal, as the pile of cinder near the old furnace amply shows. The coal was coked here and it is said to have been tried in the furnace, but the sulphur and the ash proved too much and the material was rejected after a short test. This bed has been thought to belong under the conglomerate.

The same bed is exposed at the falls of the Youghiogheny, where it varies greatly and seems to occur in pots. At the falls of Cucumber run it is badly broken up but at a short distance below the falls, it is single. On Bear run north from the river, this bed is only one foot thick but it yields very good coal.

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The lower or main portion of the conglomerate, No. 5, of the section, is not coarse throughout in any locality within the Ligonier basin. It contains many layers and pots of conglomerate, but for the most part it is a rather fine-grained sandstone. The greatest thickness is attained just south from the State line, being 325 feet at the gap of Cheat river, but it rapidly diminishes toward the north along Chestnut ridge and the rock becomes finer and less imposing, until at length in the gap of the Conemaugh it is little better than a sandstone occurring in large pots in shale. The bed thickens east and southeast from the west slope of Chestnut ridge, for it is much thicker and more imposing on the east slope in the Conemaugh gap and becomes very thick on Laurel ridge in the gap made by the same river.

This mass affords some coarse layers which have been of economical importance as they were used formerly in the manufacture of mill-stones. The rock is familiarly known as the Laurel Hill Mill-stone Grit.

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Chapter VII.

The Mauch Chunk Red Shale, (Umbral Rocks.)

Along Chestnut ridge these rocks are exposed in the gap of the Conemaugh and in all the deeper hollows thence southward to the gap of the Youghiogheny river. Within Westmoreland county, the exposures are for the most part incomplete and imperfect, as the axis is not strong enough to show more than the upper beds, and, in by far the greater portion of the area, the Pottsville conglomerate with occasional patches of overlying Lower Coals crosses the crest of the mountain unbroken. Beyond the southern line of Westmoreland the band of red shales, which first becomes distinct at a little way north from the West Newton pike, widens and the petty hollows near the crest of the ridge expose the Silicious limestone which belongs at the base of the group. Further south the axis grows stronger and the outcrop of the limestone recedes from the axial line until a short distance beyond the National road, after which the two outcrops approach until in southern Georges township of Fayette county the Silicious limestone crosses unbroken and frequently carries patches of the shales and upper limestones with it; beyond the West Virginia line the Umbral rocks are no longer exposed on the crest of the axis, being covered by the Pottsville conglomerate.

Along Laurel ridge a series of rounded knobs, extending from the Conemaugh to the National road, mark the presence of the red shales and limestones of this series at the crest of the axis. The last of these is Sugar Loaf mountain in Stewart township of Fayette, just south from the Youghiogheny river. Southward from the National road the axis flattens, and thence to the State line the band of shales is quite narrow.

Along the Youghiogheny river, as it flows across the Ligonier Valley the upper portion of the Umbral group is

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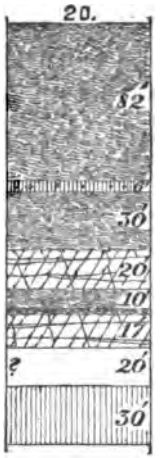
constantly above water level, except in the immediate vicinity of Ohiopyle Falls, where, owing to an abrupt rise in the bed of the river, the Pottsville conglomerate is the surface rock for a short distance.

The variations in this series are extreme and a full conception of its character can hardly be given in a generalized section. In the gap of the Conemaugh river through Chestnut ridge, the following section is shown, which exhibits the several divisions of the series:



1. Shales,	82′
2. Fossilifer's limestone,	6′
3. Shale,	30′
4. Sandstone,	20′
5. Blood red shale,	10′
6. Calcareous shale,	3′
7. Sandstone,	17′
8. Concealed,	20′
9. Silicious limestone,	30′
Total.	218′

The thickness is similar in the gap made by the same river through Laurel ridge, and in the Loyalhanna gap through Chestnut ridge the thickness is less.

In the Youghiogheny gap on the west side of Chestnut ridge the thickness is not far from 325 feet and on the east side of the same ridge it is fully 360 feet. No direct measurement of the group could be obtained in the gap made through Laurel ridge by the Youghiogheny, but a partial section obtained at a little way south from the river shows it to be 360 feet and another just north from the National road makes it 390 feet. Southward from the National road the base of the group is not exposed at any point along Laurel ridge.

Along Chestnut ridge, south from the Youghiogheny, the series was found 350 feet thick on the Dunbar furnace prop-

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erty and on the eastern side of the arch near old Center furnace the interval between the base of the Silicious limestone and that of the Pottsville conglomerate is 350 feet measured up a very sharp dip, so that the true thickness is more probably nearer 400 feet. Thence southward the thickness seems to be quite uniform, for in the gap of Cheat river a few miles south from the State line, Professor I. C. White has found the thickness to be 345 feet.

The Umbral rocks may be regarded as quadruple, 1st. A mass of shales and sandstones, including thin coal beds and some iron ores; 2d. Shale and limestone; 3d. Shale; and 4th. The Silicious limestone.

The Upper Mauch Chunk Shales.

The 1st division of the group consists of shales and sandstones and includes the *Sharon Group* of *coal beds*, which are so persistent for the most part along the west face of Chestnut ridge. Some details respecting the distribution of that group are given in Report KK, where also it is stated, that no one of the beds belonging to that group occurs on the Conemaugh river. A slide produced by a storm during the early portion of 1877 exposed the uppermost bed of the group in a side-cutting on the Pennsylvania Railroad within that gap, thus showing that the group is represented there, though it seems to be altogether absent in the Loyalhanna gap through Chestnut ridge.

Along the Chestnut ridge the Mauch Chunk shales show great variation. On the Conemaugh they consist wholly of shales, there being but a very small proportion of sandstone. And the same conditions prevail on the Loyalhanna; but on Jacob's creek, flaggy sandstone forms a very great part of the mass. On the Connellsville and Springfield pike only red shale occupies this interval. On the Youghiogheny, under the arch, the shale preponderates. On the National road, the sandstones are thick, but in the Cheat river gap there is little aside from shale.

On the east side of the ridge and in the Ligonier Valley within Fayette county, where these rocks are exposed by gorge through which the Youghiogheny river flows, the

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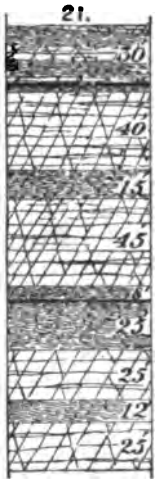
variation is quite as marked as on the west side. On the Youghiogheny, the following section was obtained:



1. Shale and sandstone,	30′
2. *Coal bed*,	2′
3. Shale,	3′
4. Sandstone,	40′
5. Shale,	15′
6. Sandstone,	45′
7. Shale,	8′
8. *Coal bed*,	1′
9. Shale,	25′
10. Sandstone,	25′
11. Shale,	12′
12. Sandstone,	25′
Total,	231′

There seems to have been a *coal bed* very near the top of the shales and close to the base of the Pottsville conglomerate, for in a cut at Bailey's Point, nearly opposite the mouth of Jonathan's run, that rock suddenly swells and cuts down into the shales. At the very base of the mass, are pots of coal, evidently remnants of a coal bed, of which every trace has been eroded at all other exposures within this region. Without doubt the bed, now lost, was equivalent to that, which on the west side of the ridge is so persistent at from 5 to 10 feet below the conglomerate. The coal bed, No. 2, of the section is thoroughly persistent along this line and, in the vicinity of Ohiopyle Falls, it is of workable thickness. No trace of limestone occurs in the section and some of the sandstones, notably No. 10, are quite conglomerate.

Southward along the west slope of Chestnut ridge, there are no exposures in detail for 150 feet below the conglomerate, but for that distance on the Wharton furnace property the shales preponderate and the interval contains a large number of iron-ore beds, but, with so far as yet known, but one *coal bed*, which is very thin. On the old clay-

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pike crossing the mountain between Springhill and Georges townships the interval is filled in great measure with shale, but the rocks are badly exposed.

Along the west slope of Laurel ridge, the exposures are all incomplete, and few of them are fully satisfactory, but the variations are quite as marked there as on Chestnut ridge. A thin coal bed occurs at but a few feet below the conglomerate on the Laurel Hill furnace property, southeast from New Florence, on the Fayette furnace property, in Springfield township of Fayette county, and on Laurel run, in Stewart township, of the same county. In Henry Clay township, of this county, a double coal bed was seen on the waters of Big Sandy belonging near the top of these shales.

The Mountain Limestone.

This portion of the series shows more marked variation than any of the rest, except the Silicious limestone. On the Conemaugh it is represented by only a few feet of very impure limestone, the fossiliferous limestone of the section first given; in the Loyalhanna gap through Chestnut ridge, it is represented by two thin layers of sandy limestone, separated by 35 feet of red shale; on Jacob's creek there are nearly 40 feet of limestone, fossiliferous throughout, but the middle portion quite argillaceous. On the Youghiogheny, this part of the series is not well exposed, but there seem to be three beds of limestone, separated by red shale. This is the character on Dunbar creek in both Dunbar and Wharton townships, the exposure being very good on both sides of the mountain.

On the National road, Shute's run and Redstone creek, along the western slope, and on Cheney's run as well as on the several forks of Meadow run on the east side of the ridge, fairly good exposures occur, showing the top limestone to be very pure, the middle quite earthy and the lower of excellent quality. On the Wharton furnace property the middle one is nearly 20 feet thick and yields a lime of very superior quality. On Cheat river a full measurement shows a solid limestone 90 feet thick. A partial section of

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this mass as shown on Decker's creek on the west side of the ridge is given in Report KK p. 101.

The Lower Mauch Chunk Shales.

These contain little of interest. On the Conemaugh in both gaps, this interval contains much sandstone, while on the Loyalhanna only red shale occurs. On the Youghiogheny, there seems to be only shale, while on the National road there is much sandstone. In the gap of Cheat river, according to Professor White, the thickness is 90 feet and the interval is occupied wholly by shale.

The Silicious Limestone.

This lies at the base of the Umbral Group and is a compound stratum. The upper portion is a conglomerate sandstone of varying thickness, in which are great numbers of more or less angular fragments of the Silicious limestone. This passes down imperceptibly into the Silicious limestone proper which in its turn passes into the Pocono sandstone below. The fragments in the conglomerate portion are so clearly free in most cases from all traces of aqueous action, that they may have been stripped off by some abrading agent, while the limestone bed was above water level.

The limestone itself is an exceedingly fine-grained rock, with a delicate blue color and on the fresh surface it shows no lines of bedding. It has a flint-like fracture and no definite cleavage. On the long exposed surface, the color is dull brown and the rock resembles a loose sandstone. Under such circumstances, the structure of the rock is perfectly distinct and it shows curious cross-bedding.

At first glance this rock is hardly to be taken for a limestone and the silica evidently predominates at all localities. At the same time lime is present in considerable quantity, for when the rock is burned it becomes snow-white, slakes readily and forms a mortar without the addition of sand.

This rock passes so imperceptibly into the Pocono sandstone that it might more properly be included with that group than with the Umbral.

The Silicious limestone is of greatest importance north-

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ward and dwindles southward. On the Conemaugh it is between forty and fifty feet thick in both gaps. A similar thickness prevails in the gaps made by the Loyalhanna and the Youghiogheny; but southward from the last the rock becomes thinner, being only about 18 feet on the National road and barely 4 feet where last seen within the State. On Cheat river it has wholly disappeared.

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Chapter VIII.

The Pocono (Vespertine) Sandstone.

As already intimated the relations of this mass to the overlying Umbral are very close, since the Silicious limestone passes down imperceptibly into the white sandstone of the Vespertine. The latter is handsomely exposed in the several gaps made by the Conemaugh, the Loyalhanna and the Youghiogheny through Chestnut ridge, as well as in most of the deeper hollows on both sides of that ridge within Fayette county. Some streams in Westmoreland cut deeply enough into the ridge to expose this rock, but for the most part they show only the lower portion of the Umbral. Along Laurel ridge it is frequently reached by the ravines both in Westmoreland and Fayette and is fully exposed in the gaps made by the Conemaugh and the Youghiogheny. But southward from the latter stream, where the ridge disappears as a ridge in the "glades," there are no exposures, as the streams do not cut deeply enough into the country to reach this rock.

On the Conemaugh under the arch of Chestnut ridge, this rock consists almost wholly of sandstone, there being only pockets of shale, of which but two, at 250 and 290 feet respectively from the top of the sandstone appear to be persistent. About midway between the two layers of shale there is a bed of silicious limestone, 4 inches thick, which seems to be the only limestone in the whole group. Thin shaly bands occasionally occur, which contain much vegetable matter and in some of them there are films of coal. Aside from this, the whole series here is devoid of both animal and vegetable remains. At the top, the rock is in thin layers, very soft bluish gray and contains much mica, but by far the greater portion is exceedingly fine-grained and bears some resemblance to quartzite. The cementing material was evidently soluble silica and in this is the chief differ-

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ence from the Silicious limestone, in which the cement was carbonate of calcium. Near the base, the rock becomes coarsely conglomerate and the pebbles in all cases are polished and rounded, so as to show that they had been subjected long to the action of running water. Here and there are irregular shaly beds with nodules of iron ore, but they are enclosed between hard rock, so that mining could not be profitable. In the gap through Laurel ridge made by the Conemaugh this sandstone shows the same character.

On the Youghiogheny, in its gap through Chestnut ridge, the exposure of the Vespertine is quite good only on the western slope of the mountain, where it is seen to be a coarse rock, quite flaggy in many portions and showing a tendency to become shaly toward the middle. The thicker conglomerate layers are well marked toward the base, where pebbles of white quartz are numerous and many of them are larger than a hen's egg. As on the Conemaugh these pebbles are clearly polished by running water. A peculiarity observed here is the exact bedding shown by those conglomerate layers containing the smaller pebbles. In the lower layers of that kind, the pebbles are flattened and arranged in almost perfect lines according to their longer axes, and the layers are from half an inch to two inches apart. These are positively characteristic of the rock and the arrangement bears no resemblance to that in any other conglomerate excepting one to be described hereafter, which occurs in the Devonian rocks. On the eastern side of this axis the character of the rocks is the same except that the middle portion is more flaggy than at the west end of the gap.

Along the National road on the west slope of Chestnut ridge, the Pocono sandstone is well shown in the vicinity of the Turkey Nest, barely four miles from Uniontown. There it is a flaggy sandstone, interstratified with numerous thin beds of shale, which are leaden-gray in color. At a little way further up the hill, great fragments of the conglomerate portions, containing both the large and the flattened pebbles in quantity, have rolled down the hill-side to the road. The same group is reached again at the summit and huge masses of the conglomerate layers lie strewn over the

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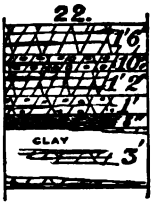
ground in the woods north from the Summit House. Just beyond that house and at a little south from the National road, the flaggy layers, belonging midway in this series, have been quarried for use as a firestone in lining blast furnaces. The same portion has been quarried at the Turkey Nest, but there it is thought to be inferior to that obtained at the top of the ridge. This portion is handsomely exposed on Dunbar creek at old Center furnace, on the line between Dunbar and Wharton townships of Fayette county. There it is very accessible for quarrying, though the means of shipping it are, for the present, exceedingly limited.

Southward from the National road, the axis of Chestnut ridge diminishes in height so that, within a short distance, the Vespertine rocks reach barely to the summit and for the most part are seen only in the deeper ravines. Crossing over the line into West Virginia, this series is found under the same arch at the gap of Cheat river, where as Prof. I. C. White informs me the thickness is 480 feet. It occurs in three distinct portions, of which the top and bottom are conglomerate while the middle one is flaggy.

On Laurel ridge the rock is less conglomerate at the exposures than it is on Chestnut ridge. For the most part it is quite flaggy and there seems to be an almost total absence of shale. The rock on Laurel ridge is much whiter than on Chestnut ridge and at many localities it seems to be almost pure white sand.

As a rule the rocks of this series are wholly non-fossiliferous, but in Victor Hollow of Fayette county, through which a branch of Georges creek flows, the following exposure was found near the base of the group:

1. Gray sandstone, . .	1′ 6″	
2. Same, but mottled and fossiliferous, ...	10″	
3. Gray sandstone, . .	1′ 2″	
4. Like No. 2, ...	1′	
5. Dark shale, ...	8″	
6. Clay and sandstone, .	3′	
Total, ...	8′ 2″	



All of these sandstones resemble quartzite and are desper-

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ately hard. Nos. 2 and 4 contain many fish spines, while the latter shows in addition numerous small and indistinct univalves. Zinc-blende and galena occur in Nos. 2, 4 and 6, but, as may be seen by reference to the summary of resources, the quantity is insignificant.

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Chapter IX.

The Devonian Rocks.

Within the Fayette and Westmoreland district, these rocks are exposed in the Conemaugh and Youghiogheny gaps, as well as in several deep gorges on the sides of Laurel and Chestnut ridges. On Chestnut ridge, north from the Youghiogheny river, the exposures are insignificant and, for the most part, the areas are too small to be represented on the map. But south from that river good exposures occur on both sides of the mountain in the Dunbar gap, in the gorges of Shute's run and Redstone creek on the west side of the ridge, and in several hollows at the head of tributaries to Big Sandy Creek on the east side. Along the west slope of Laurel ridge in Westmoreland county, they are reached by Tub-mill run and, in Fayette county, several branches of Indian creek expose insignificant areas. Southward from the Youghiogheny, they are not shown, as erosion has cut but shallow valleys in the Glade country.

Lithologically, the transition from the Pocono sandstone to the Devonian is sufficiently distinct. That great sandstone breaks down into a sandy shale, interstratified with some argillaceous shale, which in turn becomes merged into the well-defined red-gray to olive shales and sandstones representing the Devonian. After the hasty examination made in 1876, I regarded the two groups as not lithologically distinct; but the examinations made during 1877 have showed this conclusion to be erroneous.

A detailed section of the Devonian rocks presents little of interest; the general succession as compiled from the several gaps is as follows:

1. Shale and thin gray sandstones,	80′
2. White to reddish gray sandstones, with some shale,	70′
3. Reddish-gray micaceous sandstones, with red to gray and olive shales,	150′
4. Red to gray shaly sandstones, with variegated clays and shales,	200′
Total,	500′

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No. 1 is lithologically a transition mass and its sandstone layers bear much resemblance to the Pocono, rather more so indeed than to those of the lower portions of this group; but the relations of the mass are well shown by its fossils. It is exposed in the Conemaugh and Youghiogheny gaps through Chestnut ridge, as well as along the National road, as it winds up the western slope of the same ridge. How well exhibited this portion of the series may be in the Conemaugh gap through Laurel ridge I have not ascertained, but it is thoroughly well shown in the Youghiogheny gap through the same ridge. At all the localities the character is the same, the sandstones are light gray to brown and in thin beds, while the shales vary from brown to dull blue.

Of the rest of the section, by far the greater portion consists of shale and shaly sandstone. These are in almost equal proportion and alternate in layers from 2 to 4 feet thick. The sandstones are exceedingly micaceous and are little other than compact micaceous mud. Such is its character on the Conemaugh under Chestnut ridge, but in both gaps on the Youghiogheny there are some compact sandstones which would be suitable for building purposes, while further south in Chestnut ridge the Conemaugh condition is repeated. The micaceous sandstones are reddish brown to reddish gray, have a concretionary structure and, for the most part, break down readily on exposure to the weather. Characteristic fossils are found throughout the mass and many of the harder layers of sandstone have their upper surface covered by a close mat of fucoids. Such layers are scattered throughout the section.

Near the middle of the section, is a curious conglomerate from 10 to 20 feet thick, which seems to be persistent, having been seen on the Conemaugh, the Youghiogheny and the National road. In color, it bears much resemblance to that at the base of the Pocono sandstone, but the pebbles are not flattened and they are larger than those seen in any other conglomerate shown within the district. All of them are rudely oval, thoroughly rounded and polished by long rolling in water. Most of the larger pebbles are of quartz, but with these are vast numbers composed of felsite-por-

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phyry, quite soft and blackened as though by exposure before they were embedded in the cementing material. The porphyry of these pebbles according to Mr. Clarence King, to whom they were submitted, is very like that which occurs in the archean rocks of Canada.

As stated in the footnote on p. 13, I have referred these rocks to the Catskill, Formation IX. A list of the fossils found in them will be given in the last chapter of this report.

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GEOLOGY BY TOWNSHIPS.

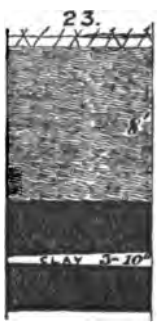
Chapter X.

FAYETTE COUNTY.

1. Henry Clay Township of Fayette County.

This is the extreme southeast township of Fayette county and lies on both sides of Laurel ridge, being bounded on the east and north by the Youghiogheny river. At the west it adjoins Stewart and Wharton. The axis of Laurel ridge enters at the north on the Youghiogheny near the sharp southward bend of the river and crosses the National pike at a little distance west from the high knob known as Hagerty's Hill. The drainage at the north and east is tributary to the Youghiogheny river, while in the southern portion Little Sandy and Gibons Glade runs are tributaries to Big Sandy, which empties into Cheat river. The exposed section extends from the *Philson coal bed* to the Devonian rocks.

On the National road the Mahoning sandstone and the *Philson coal bed* are shown at the western line of the township, and on the waters of Beaver creek the *Upper Freeport coal bed* is mined by Mr. Montague, at whose pit the exposure is:



1. Mahoning sandstone,	. . . . .	—
2. Shale, ...	. . . . .	8′
3. *Upper Freeport coal bed:*		
Coal, ...	. . .	2′ 7″
Clay, ...	. . .	3″ to 10″ } 5′ 6″
Coal, ...	. . .	2′ 3″
Total, ...	. . . . .	13′ 6″

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The clay parting in the middle of the coal bed varies at the expense of the upper bench. The same bed is mined on this stream by Mr. Moyes and Mr. Church. The coal is good but contains a considerable proportion of sulphur and ash.

The final outcrop of the bed on the west side of the Laurel ridge axis is about a mile and three quarters east from the township line and the axis crosses the road at about three quarters of a mile further east, the high hill at that point having an elevation of not far from 2,600 feet above mean tide. On the crest of Hagerty's Hill the Pottsville conglomerate dips eastward and remains in sight to Mr. Hagerty's residence. The Mahoning sandstone crosses the road within less than half a mile west from Hall's run and thence almost to the Youghiogheny river the road lies within the Lower Barrens, of which the lower portion is well shown.

About half a mile from the crossing of Hall's run the Saltsburg sandstone is shown at the roadside with a *coal bed*, 1 foot thick, at 35 feet below it. The sandstone is coarsely conglomerate. The little coal bed is mined where the road comes down to Hall's run the second time. The thickness is nearly eighteen inches.

Within a short distance of the river the *Upper Freeport coal bed* is reached and it is mined by Mrs. Lenhart and Mr. Easton. This bed is available along a branch of Hall's run for nearly a mile south from the pike and is mined by several persons. It is double but the parting is thin and the general structure of the bed bears little resemblance to that seen on the west side of the axis. The partings are numerous but very thin. The coal is tender, somewhat sulphurous, contains much ash, but is thought to be an excellent fuel. The thickness of the bed varies little from four feet.

Along the road leading from the pike to the southwest corner of the township there are few exposures. The Pottsville conglomerate is well shown near Little Sandy, but its eastern outcrop crosses to the west side of the road at somewhat more than a mile from the township line and touches

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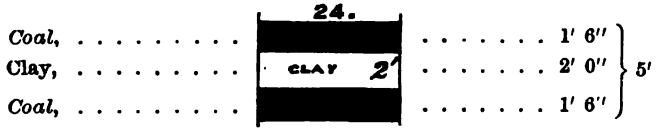
it again at the old school-house, three miles from the pike. The western outcrop of the same rock crosses this road at a mile and a half from the pike and joins the eastern outcrop just north from that road.

A narrow area between these outcrops contains rocks of the Umbral. On Little Sandy the Upper Mauch Chunk shales are well exposed but the Mountain limestone is concealed. Near Mr. Carroll's residence is a double *coal bed* which is said to have the following structure:



The lower portion of the bed is not exposed in full. The coal has been digged to a slight extent and it is said to be of very good quality. Some iron ore is associated with it but the quantity is very small.

At Markleysburg, near the headwaters of Hall's run the *Upper Freeport coal bed* is reached and the openings are numerous. In general character the bed is the same as on the pike near Somerfield. It varies little in thickness.

Along the Youghiogheny river north from the National road to Confluence only the Lower Barren rocks are exposed. The Mahoning sandstone is well shown for nearly four miles, and above it, at the proper distance, is the *Philson coal bed*, which seems to be about 2 feet thick. Immediately above the sandstone is a yellow ferruginous limestone which resembles the Johnstown ore bed. On Tubmill run, the *Upper Freeport coal bed* is mined by Mr. Collins and Mr. J. Van Sickle, who have it four feet thick and of fair quality. On the river, at rather more than two miles below Somerfield, the *Upper Freeport coal bed* is brought above water-level by a deep westward bend in the river and is rudely mined at low water by Mr. Flanagan. One exposure shows one foot of coal immediately below the Mahoning sandstone, with four feet of clay separating it from the main portion of the coal below, of which only two feet were exposed when the locality was examined.

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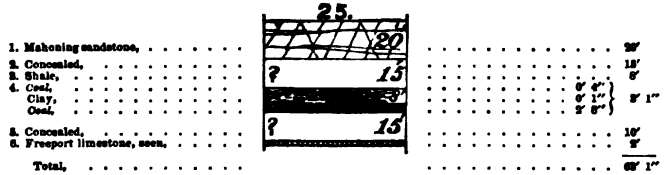
Where the road crosses the neck at somewhat more than two miles above Confluence, the Saltsburg sandstone is seen, apparently as coarse in grain as it is on the western side of the axis. Fragments of the Morgantown sandstone occur still higher, and on the north side of the neck the *Berlin (?) coal* is opened near the road with a thickness of about two feet. Several openings in this bed are worked along the river hill.

On a little run entering the Youghiogheny river at rather more than a mile below Confluence the *Upper Freeport coal bed* is mined by Mr. Tissue and Mr. Reid. On the latter property the exposure is.



The coal is very brittle and is broken by thin partings. It contains numerous streaks of brilliant bituminous matter, which do not become discolored by exposure. The proportion of ash is considerable, but the coal is popular as a fuel, and at Confluence is preferred by many to that from the *Pittsburg coal bed* as obtained from Connellsville. The limestone is imperfectly exposed, but seems to be of good quality.

On the road leading up this run there are no further exposures until the Pottsville conglomerate is reached at the township line. There the outcrop of that rock crosses southward and fringes the hills around the head waters of Laurel run, leaving the township to enter Stewart about one mile from the line of Wharton township. The section within this area reaches to the base of the Pocono sandstone, and no doubt to the Devonian rocks, which, however, are not exposed.

An extensive area of the Umbral rocks occurs on the main fork of Beaver creek within this township. The thickness of the group is very nearly four hundred feet. The Silicious limestone is well exposed and exhibits the

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ordinary characteristics; but the mountain limestones are very imperfectly shown. The Upper Mauch Chunk interval is occupied mostly by sandstones and there are no traces of the iron ores belonging to that portion of the series.

2. Wharton Township of Fayette County.

This adjoins Henry Clay at the west, and is west and south from Stewart. Its western boundary is the crest of Chestnut ridge. The drainage in the southern portion, by means of Big Sandy and its tributaries, leads to Cheat river, but in the northern portion, Meadow run, Laurel run and Dunbar creek, all flow to the Youghiogheny river. The synclinal of the valley crosses the National road at two miles west from the village of Farmington, but, southward from that road, it becomes somewhat obscure, as the trough becomes very shallow toward the State line. The exposed section in the township extends from midway in the Lower Barrens to the Devonian rocks.

Little Sandy or Glade Run.—On this stream the *Upper Freeport coal bed* was once opened about half a mile below Shinbone Alley, but the pit has long been deserted. The coal is said to be nine feet thick and of good quality. It lies directly under the Mahoning standstone, which here is 37 feet thick and somewhat coarser than usual. The Freeport limestone is rather more than nine feet thick and yields a very excellent lime.

At the first bridge below the village of Shinbone the Freeport sandstone comes up from the run. It is a coarse gray rock, very massive and for some distance its fragments cover the surface. Over it is the *Lower Freeport coal bed*, which is four feet thick and of good quality. At ten feet below the sandstone is the *Lower Kittanning coal bed*, 2 feet 6 inches thick, with which a limestone is occasionally associated. No further exposures occur until near Dennis' saw-mill, where the *Clarion coal bed*, four feet thick, is exposed at the roadside. At the saw-mill the Pottsville conglomerate is reached. On the road leading from the saw-mill to the National road the *Upper Freeport coal bed* is mined on the old Shepard place and is easily accessible to

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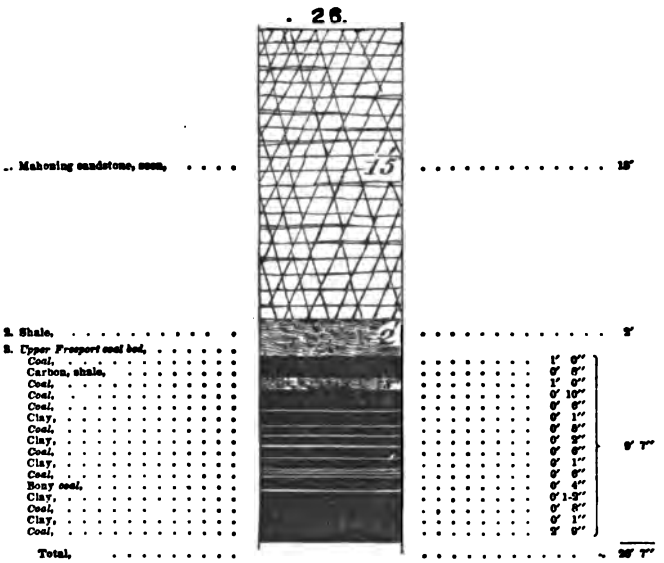
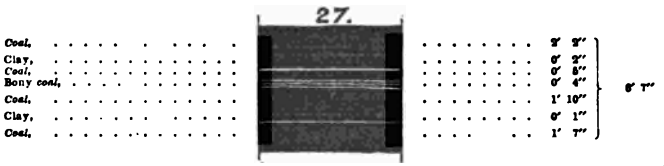
the township line in the hills between the Little Sandy and Gibbons Glade run. The bed varies little from five feet, the clay parting being included.

Big Sandy Creek.—At a short distance north from the State line, Grosses run enters Big Sandy. On this stream, near the clay pike, Mr. H. Seaton mines the *Upper Freeport coal bed*, which shows:



This measurement was obtained at the mouth of the pit, but at twenty yards inside the structure is altogether different, being:



The coal obtained inside of the pit is said to be very good and it is well liked for fuel. On the same property the Freeport limestone has been opened and found to be ten feet thick with the bottom not yet reached. On the west side of the run is Mr. Fisher's opening in a four feet coal

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bed. There are no exposures in the immediate vicinity of this opening but the bed is most probably the *Clarion*.

On the clay pike the Pottsville conglomerate crosses the road about two thirds of a mile from Grosses run, and thence to the summit of Chestnut ridge the road lies in the Umbral rocks, the Silicious limestone being reached at the summit. On the Seaton road there are no exposures, but in the hollows between these roads, as well as in those south from the former there are many imperfect exposures of the Lower Carboniferous rocks. None of the hollows is cut deeply enough to exhibit the Devonian rocks, which are not reached along this ridge until the head of the main fork of Grosses run.

On the main stream of Big Sandy the exposures are imperfect until below Elliot's mill or Shinbone post office as it is on the map. Nearly a mile above this mill, on a branch of the creek, the *Upper Freeport coal bed* is mined, and at the saw-mill, where this run is crossed by the Farmington and Shinbone Alley road, the Mahoning sandstone is exposed.

Along Big Sandy the *Upper Freeport coal bed* is again reached in the hills at the mouth of Cheney's run. On this stream the Morgantown sandstone is exposed on the hill opposite Wharton furnace, where it is shown to the thickness of 20 feet. The rock is mostly fine-grained though it contains occasional pots of conglomerate. As far as seen, it is massive, shows no lines of bedding and weathers dull gray. It splits handsomely and it was used at Wharton Furnace both for building and for lining the furnace. On the east side of this hill the *Elk Lick coal bed* was once opened and was found to be somewhat more than two feet thick. On the same side of the hill on the furnace property the Black Fossiliferous limestone is exposed two feet thick, embedded in black shale and having a four-inch coal bed at 3 feet below it, which rests on a rather lean kidney ore. At eighty feet above the Black limestone fragments of the Green Fossiliferous limestone were seen.

At 280 feet below the Morgantown sandstone, measured up the dip, the Bolivar fireclay is exposed in the road lead-

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ing down the run from the furnace. The Mahoning sandstone forms a small bluff in the hill above the road and at one time the *Upper Freeport coal bed* was mined here. Respecting the thickness of the coal bed no definite information could be obtained, as the opening has been long deserted and no one knows anything about it. The fireclay is about ten feet thick, quite light blue, non-plastic, varies much in quality and as usual is associated with lump iron ore.

On the opposite side of the run a coal bed is exposed, which was benched for a long distance up the hill-side. At an opening now worked, the coal is exposed for 2 feet 6 inches but at some distance inside it becomes 3 feet. At from 6 to 10 inches below this bench is another, 6 inches thick. The coal is a very fair fuel, though pieces lying on the dump show that it contains a considerable proportion of sulphur and ash. At 30 feet above this bed, the interval being occupied by shale, is another bed, which has been mined. When visited the pit was almost closed by a fall at the mouth and little could be learned by direct examination. Near the mouth the bed is said to be 6 feet thick, but it soon becomes only 4 feet. On top it has a thin layer of compact carbonaceous shale. The coal is thought to be quite good. This bed is the *Lower Kittanning*. Above it is argillaceous shale passing upward into a shaly sandstone, the whole exposure being 12 feet. Between this and the Bolivar fireclay everything is concealed.

At a little distance northwest from the furnace the *Brookville coal bed* is exposed in the road at about 15 feet above the Piedmont sandstone and appears to be not far from 2 feet thick. The *Mount Savage coal bed* was once mined near the furnace as well as at two pits probably one fourth of a mile southwest from it. As all these pits have fallen in the bed cannot be measured. It is said, however, to be nearly four feet thick and to yield strong coal. Its value as a coking coal was tested by the firm that operated the furnace, but the coke, though compact and strong, was too sulphurous to be of any use.

The lower division of the Pottsville conglomerate seems to be not more than 50 feet thick and for the most part is but

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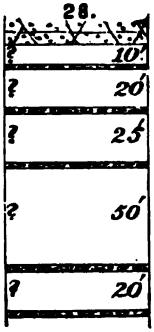
a coarse-grained sandstone with only occasional pebbly layers. It is well exposed at the furnace and its outcrop line along the base of the mountain passes but a little distance west from the furnace stack.

On the Wharton Furnace property the Umbral iron ores were mined energetically both by benching and drifting. The lines of benching extend for long distances both north and south from Cheney's run, but the drifts and other workings are in wretched condition and no direct information respecting the thickness of the beds or the character of the ores can be obtained. On a hill-side, about one fourth of a mile west from the furnace the following section was measured:



1. Pottsville conglomerate,	—
2. Interval,	10′
3. Little Flag ore bed,	—
4. Interval,	20′
5. L'tle Honeyc'b o. b.,	—
6. Interval,	25′
7. Big Flag ore bed,	—
8. Interval,	50′
9. Big Honeycomb ore bed,	—
10. Interval,	20′
11. Huston ore bed,	—

A still lower bed known as the Big Bottom was once opened on this hill, but the pit is now concealed.

The Mountain limestone was quarried on this run at somewhat more than a mile from the furnace. Only the middle and lower beds are now exposed, and they are separated by about 40 feet of shale. The upper of these is 20 feet thick, compact and loaded with fossils. The specimens in the harder portions are crushed, but those from the argillaceous portions are in excellent condition. This was quarried to supply the furnace. The other bed is 8 feet thick, blue, free from clays, contains many fossils, and yields a beautifully white lime. Between this and the Silicious limestone there is an alternation of shales and sandstones not shown in detail. One layer of sandstone is locally celebrated as the "Grindstone Rock," and it is much used for that purpose.

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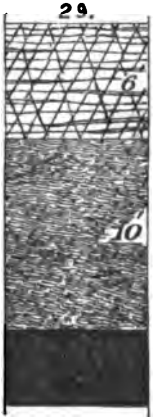
The Silicious limestone shows the ordinary character and rests directly on the Pocono sandstone. Further up the run occasional outcroppings of the Devonian rocks occur, but there are no connected exposures.

Above the mouth of Cheney's run no exposures were found on Big Sandy until very near the road leading from Fayette Springs to Wharton Furnace, just below which is a deserted opening in the *Lower Kittanning coal bed* where the exposure is :

29.



1. Flaggy sandstone, . .	6′
2. Shale, ...	10′
3. *L'wer Kittan'ing coal bed*, ...	4′
Total, ...	20′

The shale overlying the coal bed is argillaceous below, but becomes somewhat arenaceous above and contains numerous impressions of coal plants. The coal is now wholly concealed, as the face of the cliff has fallen for a distance of 40 or 50 feet, covering the mouths of all the openings. The upper portion of the bed for 6 inches is said to be a cannel-like shale.

On a little branch coming in here is the somewhat celebrated Fayette Spring, issuing from shale at 100 feet below the Mahoning sandstone. Reference to it will be made in another chapter. Following up the road leading past the spring to the National road, one soon reaches the Mahoning sandstone, which here is but a flaggy rock. The *Upper Freeport coal bed* is not exposed, but below its place for 60 feet there is a clay shale, imperfectly bedded and containing a large quantity of nodular iron ore.

As one approaches the pike along Big Sandy, he comes

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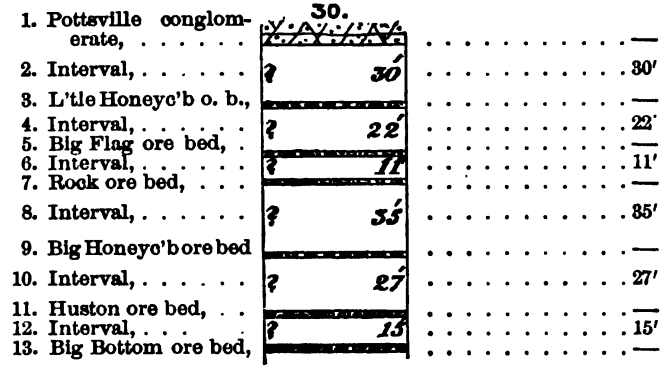
upon an extensive series of drifts in the Umbral ores which were worked eight or ten years ago to supply Wharton Furnace. The measurements obtained there are as follows:


30.
1. Pottsville conglomerate, ... —
2. Interval, ... ? 30′ . . . . . 30′
3. L'tle Honeyc'b o. b., ... —
4. Interval, ... ? 22′ . . . . . 22′
5. Big Flag ore bed, ... —
6. Interval, ... ? 11′ . . . . . 11′
7. Rock ore bed, ... —
8. Interval, ... ? 35′ . . . . . 35′
9. Big Honeyc'b ore bed . . . . . —
10. Interval, ... ? 27′ . . . . . 27′
11. Huston ore bed, ... —
12. Interval, ... ? 15′ . . . . . 15′
13. Big Bottom ore bed, ... —

The details respecting these ores, in so far as they can be obtained, are given in the chapter on the iron ores. The beds are from three to ten inches thick, and the percentage of metallic iron varies from 22 to 35. In nearly every instance the ore is an oxide on the crop, but except the Little Honeycomb and the Little Flag, they all change to a carbonate within a short distance under the hill.

The intervals between the ore beds are filled for the most part by dull red shales, but a flaggy sandstone, 10 feet thick, usually covers the Rock vein and a somewhat similar rock rests on the Big Bottom. At a few feet above the Big Honeycomb is a fine plastic fire-clay, 4 feet thick, immediately underlying a thin *coal bed*, which seems to be the only representative of the *Sharon Coal group* south from the National road on the east slope of Chestnut ridge.

On this furnace tract there occurs at not more than ten feet below the Big Bottom another ore bed known as the Red Belt, which derives its name from the peculiar color of the overlying shale. This ore is of little value.

Near the National road are two quarries at which the Silicious limestone has been quarried for use in repairing the pike. The rock shows the usual characters at both quarries, but at one it is roofed by a reddish shale, while at the other it underlies a rather compact sandstone. Below, it gradually merges into the Pocono sandstone.

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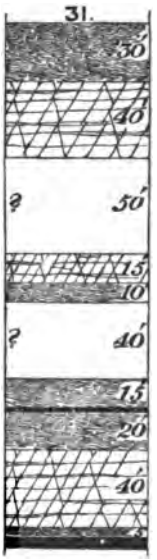
Along the National Road. Just east from Farmington a fork of Meadow run crosses this road. Beginning at a little distance south and then following the road westward to the synclinal, which crosses near the toll-gate at two miles from Farmington, the following section was obtained:



1. Shale,	30′
2. Sandstone,	40′
3. Concealed,	50′
4. Sandstone,	15′
5. Shale,	10′
6. Concealed,	40′
7. Shale,	15′
8. *Pittsburg coal bed*,	2′
9. Shale,	20′
10. Mahoning sandstone,	40′
11. Shale,	5′
12. *Upper Freep't c'l b'd*	0′
Total,	273′

The *Upper Freeport coal bed* is not exposed in the creek at the pike, though at a little distance south from that point it has been stripped out of the bottom. At a mile from the pike the coal has been mined on this creek by Mr. Dean, and it is now mined by Mr. McCartney. The bed is double, the benches being 2 feet 6 inches to 3 feet and 1 foot to 1 foot 6 inches, separated by 1 foot 6 inches of clay. The coal is quite good and is used in the vicinity, but many of the residents prefer to haul their fuel from the *Pittsburg* bed in North Union township.

The Mahoning sandstone is first seen in the road immediately east from Farmington and thence eastward to the township line it is frequently exposed along the pike. It is irregularly cross-bedded, very light gray but speckled near the outcrop with small stains of iron, which give it a

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very peculiar appearance. The rock contains some white mica, some feldspar and is mostly fine-grained though some of the layers are slightly conglomerate. The same rock, as well as the *Upper Freeport coal bed*, remains above water level along Meadow run to the line of Stewart township.

The *Philson coal bed* is seen on the pike only at Farmington and eastward, but its blossom was seen at various places along Meadow run as well as on the road leading from Farmington to Elliot's mill. No openings in this bed were found, but the roadside exposures show the coal to be very hard and in large measure quite slaty. The spring supplying the watering trough just east from Farmington flows off this coal.

The interval, No. 6, contains a small *coal bed* near Farmington, which is much better exposed near the Stone House hotel, four miles west from Farmington, where it is 2 feet 6 inches thick and is mined. The sandstone, No. 2, is exposed near the Presbyterian church west from Farmington and at half a mile further west it is strewn over the fields in huge blocks. It doubtless represents the Saltsburg sandstone. Near the church it is flaggy but in the fields beyond it is massive. The concealed interval, No. 3, contains a thin *coal bed*, which at one time was mined near the church, where it was found to be somewhat more than 2 feet thick and to be associated with an irregular limestone.

The upper members of the section remain in sight to the Stone House, the eastern outcrop of No. 2 being at half a mile east from that house. West from that locality there are no exposures until near Mr. Snider's residence, where the Pottsville conglomerate is reached. The Piedmont sandstone is a fine grained massive rock, very light gray and exceedingly pure. Under it is the *Mount Savage coal bed*, nearly four feet thick, which is mined by Mr. Snider and yields a very fair coal. The Pottsville conglomerate is a massive rock containing occasional pebbly layers, but it is by no means so coarse as the Pocono sandstone. The Umbral rocks are moderately well shown along the pike near Mr. Snider's house, where the limestones of the group have beeu quarried and drifts have been run in on the ore

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beds. The Pocono sandstone comes up east from Mr. Snider's and owing to the sharp grade in the road remains in sight to the summit, where the coarse conglomerate near the base is well exposed. The flaggy middle portion is quarried near the summit for use as a firestone. Rock from this quarry was employed in lining Mr. Oliphant's new furnace and it is shipped largely to the Edgar Thompson Steel Works.

Along Meadow run within the limits of this township, the exposures are few and unsatisfactory. The *Upper Freeport coal bed* is available the whole way and is mined near the western outcrop by Mr. Harrison Wiggins. Near the summit of the mountain the Umbral ores were once benched for use at Coolspring furnace, but the works are in a condition of hopeless decay and one is unable to ascertain even the number of the beds. Mr. F. H. Oliphant, for whom the ores were digged, asserts that they are of excellent quality and that the ore from one of the beds is fully equal to the Blue Lump of the Pittsburg Group. The forks of Meadow run barely expose the Devonian rocks near their heads.

Dunbar Creek.—This heads in Chestnut ridge near Dunbar's Camp and flows northwardly and northeastwardly until it passes out of this township near Center furnace. The western outcrop of the Pottsville conglomerate lies east from the creek and occasionally small patches of the Lower Productive Coal Series are caught in the hills near the stream. The region drained by this creek is for the most part a wilderness and details can be obtained only with the utmost difficulty.

At Center furnace the creek is joined by Laurel run. Between the two streams a high hill rises, on which the conglomerate is exposed fully 50 feet thick, but the lower portion only remains, the *Mount Savage coal bed* and the Piedmont sandstone having been removed by erosion. Underlying the conglomerate but a few feet is a peculiar iron ore which must occur in considerable quantity, as it was benched extensively for use at Center furnace. Fragments show it to be reddish brown and much like a roasted ore,

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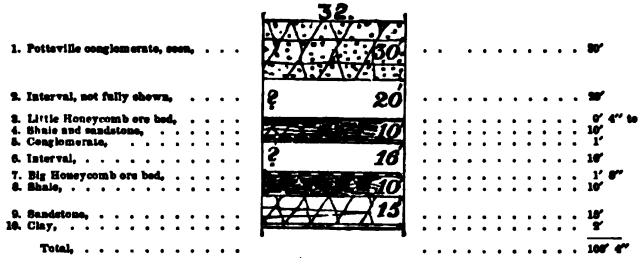
while the freshly exposed surface has some resemblance to an impure micaceous ore. In descending from the conglomerate to the furnace, one finds the Umbral group to be 350 feet thick, but it is wholly concealed except the Silicious limestone, which is seen passing into the Pocono sandstone, of which a cliff overhangs the old furnace stack.

On Laurel run about a mile from the furnace the Pottsville conglomerate is reached and the stream falls over it. No definite exposure of the Piedmont sandstone was found and no evidence of the presence of the *Mount Savage coal bed* was observed. A short section obtained between this point and the mouth of Rock run, a distance of one eighth of a mile, is shown in Fig. 32:


32.
1. Pottsville conglomerate, seen, . . .
30
2. Interval, not fully shown, ...
?
20
3. Little Honeycomb ore bed, ...
4. Shale and sandstone, ...
10
5. Conglomerate, ...
6. Interval, ...
?
16
7. Big Honeycomb ore bed, ...
8. Shale, ...
10
9. Sandstone, ...
10. Clay, ...
13
Total, ...
0' 4" to 0" 10' 1' 10' 1' 0" 10' 15' 2'

The Pottsville conglomerate has the usual characteristics, contains numerous pebbly layers, among them one whose pebbles are water-worn fragments of iron ore. Some layers are rich in impressions of plant stems. The interval, No. 2, is occupied by sandstone and shale, not exposed in detail. The former shows many excellent stems of *calamites* well preserved and several feet long, though very slender. In the latter there is a bed of cannel-like shale, 10 inches thick.

The Little Honeycomb is a very fine grained ore, bluish-gray and somewhat micaceous. It is not a continuous plate, but is made up of flattened nodules, so closely packed as to be a layer. The ore seems to be of a superior quality but it was not used at the old furnace. No. 5 is a curious conglomerate, made from fragments of iron ore and the Silicious limestone with some sand, the whole being cemented by carbonate of iron. The layer is persistent along a line of nearly a mile and is well exposed on both Laurel

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and Rock run. Though containing a considerable proportion of iron, it holds so much foreign matter as to be valueless. The presence of fragments of the Silicious limestone suggests the existence of an anticlinal at no great distance from this locality. The interval between the conglomerate and the Big Honeycomb contains only shale.

The Big Honeycomb is a double bed, thus: Ore, 4 inches; clay, 10 inches; ore, 6 inches to 8 inches.

The upper layer is decidedly silicious and in all probability is of little value. The lower layer is a very pretty ore and much of it is geodal. The interior of the geodes is lined by small but beautifully perfect crystals of chalybite accompanied by numerous small crystals of quartz, some of which are half an inch long. Many pieces show a considerable quantity of crystalline quartz, which may perhaps detract somewhat from the value of the ore.

The other ores belonging to this group are not exposed along the run. Nearer the furnace one of the layers of the Mountain limestone is exposed and from it the limestone was obtained for use at the furnace. At the furnace the flaggy layers of the Vespertine or Pocono sandstone are in the creek bed.

3. Stewart Township of Fayette County.

This township lies north from Wharton and Henry Clay. It is divided by the Youghiogheny river and the crest of Laurel ridge is its eastern boundary. The axis of that ridge crosses the Youghiogheny river near the 78th mile post, somewhat more than three miles east from Ohiopyle Falls. The synclinal crosses the same river midway between the mouths of Jonathan's run and Bear run. The section extends from nearly 500 feet above the *Upper Freeport coal bed* to the Devonian rocks, the last being fairly well shown in the Laurel ridge gap.

Along the Youghiogheny River.—The Pottsville conglomerate comes down to the river from the southeast at Ohiopyle Falls, but no satisfactory exposure of the mass is given in the hills. Its thickness is not far from 100 feet. The Umbral rocks are almost wholly concealed, the Silicious

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limestone alone being exposed. This is shown at a mile and a quarter above the falls and rests directly on the Pocono sandstone, which forms a cliff on the hill-side and is barely 300 feet thick. This sandstone varies from shaly to compact and some portions are quite compact.

In the first rock cut, nearly two miles above the falls, the Pocono sandstone is seen resting directly on the Devonian rocks, the whole mass dipping west-northwest at the rate of 20 degrees. In this cut the exposure is nearly 200 feet thick and the Devonian rocks consist mainly of brownish red shales and sandstones, the latter being micaceous and without regular bedding. Their tendency is to weather into rounded surfaces as if having a concentric structure. Throughout the rock is argillaceous and some of the shales are distinctly olive. Many layers show surfaces matted with fucoids, while others are crowded with characteristic mollusks.

From this cut there is a concealed gap extending in line of dip nearly half a mile. Were the dip to retain its abruptness, this interval should contain 500 feet of rock; but on the eastern side of the gap the dip is very much less than on the western side and the thickness of the concealed interval is therefore much less than 500 feet, and in all probability it is little more than 200 feet, if the relations between the different portions of the group are the same here as under the arch of Chestnut ridge. In the next cut the exposure is: (Fig. 33.)

33.

1. Red shale,	30′
2. Sandstone,	5′
3. Red shale,	5′
4. Sandstone,	45′
5. Shale,	5′
6. Concealed,	12′
7. Conglomerate sandstone,	5′
8. Shale,	5′
9. Sandstone,	20′
10. Fissile shale,	5′
11. Sandstone,	5′
12. Shale and sandstone,	30′
13. Sandstone,	20′
Total,	190′

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No. 4 is for the most part fine-grained, gray, compact, but contains some conglomerate and some pots of shale near the top. In the upper layers fucoids occur in great numbers. Nos. 7, 9, and 11, contain conglomerate layers and in No. 11 the pebbles are very large. A large part of No. 9 is flaggy, almost laminate and the bed shows distinct jointing throughout. This section is exposed near the 78th mile post, where the axis of the Laurel ridge anticlinal crosses the river.

The sandstone, No. 4, was next seen on the east side of the axis, near Mr. J. Morrison's house, and in this vicinity the following section was obtained: (Fig. 34.)

1. Sandstone,	10′
2. Concealed,	20′
3. Shale,	30′
4. Sandstone,	6′
5. Shale,	25′
6. Shale and thin sandstone,	15′
7. Sandstone,	30′
8. Concealed,	90′
9. Sandstone,	35′
Total,	261′

The sandstone, No. 7, of this section, is the same with No. 4 of the last, so that in this, 68 feet of the missing interval is reached. No. 4 of this section is gray, contorted, has pots of gray and drab shale, and contains imperfect impressions of plant stems. The lower portion is very compact, and the rock would be a good building stone. The thin sandstones of No. 6 are somewhat conglomerate. No. 1 is dark reddish-brown, soft, micaceous and flaggy, and in general appearance bears much resemblance to the brown stone used in New York city for building purposes. It

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seems to be quite soft when first taken from the quarry, but, on exposure, it hardens so as to be a very durable stone. It has been quarried near the county line, alongside of the railroad. The whole section was carefully examined for fossil remains, but aside from the indistinct fucoids referred to, none was found.

Following the railroad and river down from the point above Ohiopyle, where the conglomerate reaches the river, one finds the upper portion of that rock forming the river bed above the falls to beyond the bridge. This portion, the Piedmont sandstone, is for the most part quite coarse, many of the layers being crowded with pebbles, some as large as an almond. In all cases the pebbles are smooth as though they had been long subjected to the action of running water. This Piedmont sandstone is almost 30 feet thick, and is the rock over which the water flows at the falls.

Immediately below the falls the *Mount Savage coal bed* is seen under this sandstone, is from zero to 15 inches thick, and it has been digged on both sides of the stream. The quality of the coal is said to be very good. The lower portion of the Piedmont sandstone is badly twisted, and contains discs and pots of coal, of a shape such as might be expected when a soft mass is entangled in the sandstone and submitted to heavy pressure. Sometimes the coal occurs in mere films between the contorted layers, and at others it seems to be a continuous mass for a few yards, with a thickness of several inches. Below the coal comes the conglomerate proper, which, below the falls, forms the banks of the river. It varies much in character, some portions being quite fine-grained, while others are very coarse.

Here the river makes a long horse-shoe curve, the distance being nearly two miles, while across the neck it is barely 300 yards. In making this bend, the river falls 87 feet, so that on the lower side the upper Mauch Chunk shales are reached. The total thickness of the conglomerate, including the Piedmont sandstone, is barely 100 feet.

On the peninsula within this curve the following section was obtained: (Fig. 35.)

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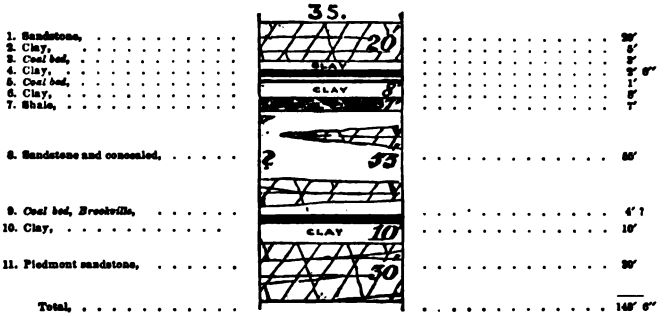
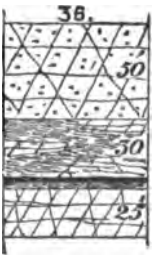


The section to and including No. 7 was obtained in a well; the remaining portion was seen in the river bank. The sandstones are very massive and the lower one, No. 6, is fully 30 feet thick. The upper coal bed, Nos. 3, 4 and 5, is quite good but no attempt has been made to work it. The lower bed is no longer exposed, but the number of deserted openings shows that at one time it was mined quite extensively. The thickness is given on information and the coal is said to be very good. The same bed is exposed in the railroad cut immediately west from Ohiopyle station, where it is seen to be a double bed, the two portions being separated by 8 feet of shale. In this cut the Piedmont sandstone is imperfectly exposed.

In a long cut, beginning at a little way from Ohiopyle and continuing to the water tank, the Pottsville conglomerate is seen rising rapidly above the track, so that midway in the cut the Upper Mauch Chunk shales are exposed. The section here is:



1. Pottsville conglomerate,	50′	
2. Shale, with thin sandstones,	30′	
3. Coal bed,	1′ 3′	to 2′ 9″
4. Shale,	3′	
5. Sandstone,	25′	
Total,	110′ 9″	

The conglomerate is quite coarse and many of the pebbles are twice as large as a pea. The coal bed has never

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been mined but it seems to contain little ash and should yield a good fuel. Aside from a few nodules, no iron ore was observed in the shales. The sandstone, No. 5, is well exposed near the water tank. Owing to the course of the river the rocks rise rapidly down stream so that between Jim's run and Bear run the conglomerate is high up in the hill, but as the latter stream is approached that rock comes down toward the track and is exposed as a magnificent cliff. At two hundred yards east from the 71st mile-post it is within ten feet of the track and from that point it rises in each direction.

At Bailey's Point, opposite the mouth of Jonathan's run, the following section was obtained:

37.
1. Pottsville conglomerate,
2. Shale and sandstone, 20'
3. Coal bed, 1' 6"
4. Shale, with iron ore, 2' to 7'
5. Coal bed, 1" to 2"
6. Clay, with some iron ore, 2'
7. Sandstone, 6'
Total, 47' 6"

At 8 feet above No. 3 there is carbonaceous shale 18 inches thick. The coal bed shows the following structure: *Coal*, 10 inches; clay, 1 inch; carb. shale, 2 to 4 inches; *coal*, 3 to 6 inches. The carbonaceous shale has regular cleavage and comes out in blocks. The whole bed is very impure but it is clearly the same with that of the last section. The little coal, No. 5, is sadly distorted and broken. The ores in Nos. 4 and 6 are evidently of no economic value, as they are only nodular. That in No. 6 occurs in considerable quantity and is of good quality, but the quantity is not sufficient to make it important. Between this and Bear run, a distance of one eighth of a mile, the coal bed describes four marked curves, each petty synclinal carrying it below the track.

Near the 71st mile-post, the Pottsville conglomerate forms a cliff, in whose face a great cavern has been eroded by the weather. The mass is somewhat thicker here than is usually the case as it has cut out much of the underlying shale. At the base for ten feet it contains fragments of a *coal bed*, some of them quite large. This bed has no representative in any section obtained along the railroad, so that

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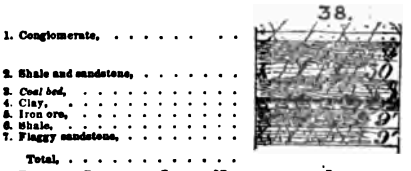
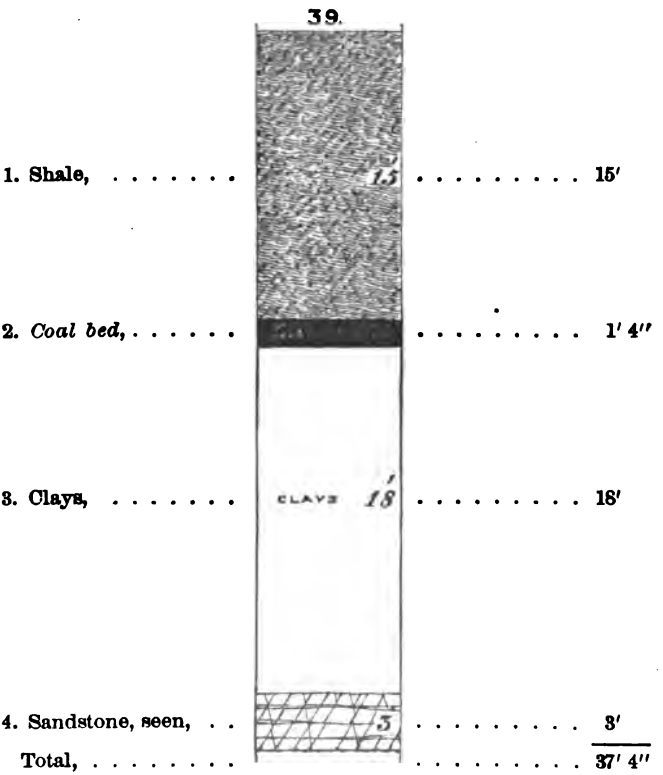
in all probability it was removed from the whole area during the deposition of the conglomerate, and these fragments are all that remain to tell of its existence. It may be equivalent to the little bed so persistent immediately under the conglomerate on the west side of Chestnut ridge.

In the next long side-cutting west from Bailey's Point, the exposure is: (Fig. 38.)



And at the 70th mile-post the section is: (Fig. 39.)



In the latter section the coal bed is in two benches, 10 and 2 inches, separated by 4 inches of shale and is slaty

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throughout. The ore in the clay below the coal is quite variable both in quantity and quality, so much so that no conclusion respecting its value can be reached. Within a short distance here it varies from 3 feet to a mere line of insignificant nodules. In the second section the clays below the coal bed contain coal streaks. The same clays contain abundance of plant stems and occasional impressions of leaves. In both sections the sandstone show many stems.

The interval between the coal and the sandstone shows a decided thickening westward from Ohiopyle, and in a cut just above the mouth of Laurel run it is still further increased, the detailed section being as follows:

The sandstone is just below the track, but is well exposed on the opposite side of the run in Springfield township. No. 8 consists of

Coal, 1 inch; clay, 10 inches; carb. shale, 5 inches; clay, 8 inches; carb. shale, 4 to 8 inches. The carbonaceous shales are very compact and come out in blocks. They as well as No. 10 contain great numbers of vegetable impressions, mostly belonging to *Calamites*. On the opposite side of the run a layer of shale at this horizon shows many fine impressions of leaves.

South and West from the Youghiogheny River.

Laurel Run. This is a tributary to Meadow run, entering it at nearly a mile from the Youghiogheny river. On this stream the Pottsville conglomerate comes up nearly a mile from its mouth and soon rises so as to form the crest of the hills on the south and west sides of its drainage area. Where the road leading to Sugar Loaf mountain crosses the run the Upper Mauch Chunk shales are reached and one of the *coal beds* belonging to that group is exposed, while further up the stream the Mountain limestones and the Silicious limestone are fairly well shown. The last

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rests directly on the Pocono sandstone. On the ridge, of which Sugar Loaf is a portion, only the Lower Carboniferous rocks are shown toward Laurel run, but on the opposite side toward the river, the Devonian rocks are exposed in a broad deep ravine. On Sugar Loaf itself the Silicious limestone was seen in and above the road, while near the crest of the hill the several layers of the Mountain limestone are partially exposed. Along this road, which leads to Confluence, the conglomerate is reached at the line of Henry Clay township.

Meadow Run. This large stream enters the Youghiogheny at but a short distance below the falls. At its mouth the Pottsville conglomerate forms abrupt walls on both sides. The road leading by this stream crosses the neck of a large curve, so that at one third of a mile, the *Brookville coal bed* is reached and its blossom is exposed at the roadside. No further exposure occurs until the road again reaches the creek, but the hillside is covered by immense blocks of the coarsely conglomerate Saltsburg sandstone. At somewhat more than a mile from the river Mr. Potter mines the *Upper Freeport coal bed*, which at his opening is nearly five feet thick, with the Freeport limestone well shown at about four feet below it.

At the hill-top between this stream and Laurel run great fragments of the Saltsburg sandstone were seen on Mr. Joseph Leonard's property. The rock is not in place and no measurement of its thickness can be made. Mr. Leonard has opened the *Upper Freeport coal bed* and at his pit it varies from 3 to 5 feet, showing the latter thickness near the mouth of the entry. Below it, is clay, 2 ft. 6 in. with nodular iron ore, which rests on the Freeport limestone, of which 2 ft. are exposed. The Mahoning sandstone is seen above the coal and seems to be barely 40 ft. thick, for at that distance above the coal there is an impure or ferruginous limestone with which a thin coal bed is said to be associated.

On a little stream flowing through this property to Meadow run the following section was obtained:

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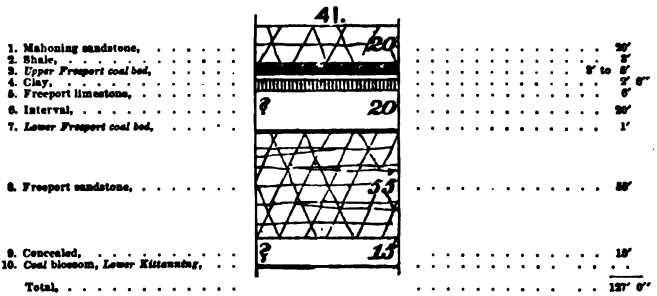
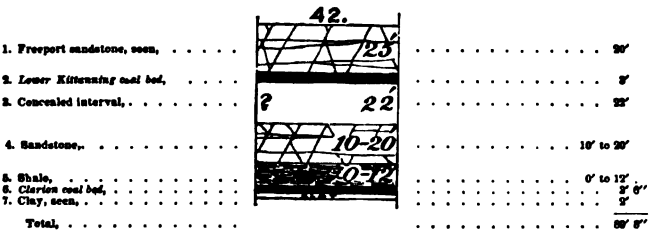


In the vicinity of the Leonard property, there seem to have been many openings on the *Upper Freeport coal bed*, but all have been deserted, though the coal from them is said to be quite as good as that from the openings now worked on Meadow run. The Freeport sandstone occurs in a bold cliff, which is fully exposed by this little run as well as by the road leading to Meadow run.

On Meadow run, about a mile above this locality a section was obtained on Mr. G. Potter's property, which is continuous with the last.



The Freeport sandstone is well exposed along the run and its cliff is easily followed. At this exposure it is flaggy, though much twisted at the base. The *Lower Kittanning coal bed* is for the most part a rich carbonaceous shale, with a 6 in. layer of bituminous coal at the bottom. No. 4 is a variable compact sandstone, varying at the expense of the underlying shale and sometimes cutting out even a portion of the *Clarion coal bed.* That coal bed is mined by Mr. Potter. It is separated into three distinct benches but the partings contain no shale. The coal from this bank is said to be very a good fuel.

At one time the *Lower Freeport coal bed* was mined on

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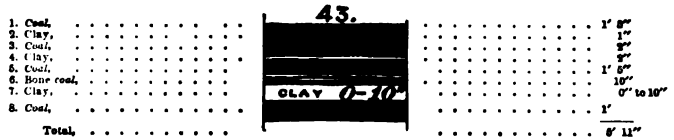
Mr. I. Collins' property, where it is 5 ft. thick, but it is so badly broken by thin slates that working is unprofitable.

From this locality to the line of Wharton township along the main fork of Meadow run as well as on the branch heading near Farmington, the *Upper Freeport* is accessible in the hills and the Freeport limestone seems to be rarely absent.

On Beaver run, which enters Meadow run at two miles below the line of Wharton township the Freeport sandstone is continuously exposed to the township line. At one-fourth of a mile above the mouth of this stream the *Lower Kittanning coal bed* is exposed in the bluff, 5 ft. 11 in. thick and underlaid by 25 ft. of shale and clay to the run. The coal is sadly distorted by pots of clay, sandstone and iron ore so that no section of it can be made. Many slates break up the coal and pyrites is abundant so that the mass is utterly worthless. The Freeport sandstone, as on Mr. Potter's property, is flaggy and contains immense numbers of vegetable impressions. The bottom is very irregular and the top layers of the coal curve with the bottom layers of the sandstone.

At a short distance further up a massive sandstone is shown in the run, but in the absence of exposures in the immediate neighborhood, it was found impossible to determine whether this be the Pottsville conglomerate or the thick sandstone between the *Brookville* and *Clarion coal beds*. It is clear, however that an anticlinal axis crosses the run here, for at barely one fourth of a mile below the township line the Freeport sandstone is seen in the hillside and the *Clarion coal bed* is mined at a few feet above the level of the run. The structure here is so different from that observed at the Potter pit that I give it in detail, thus:



The coal from this bed must be quite inferior, for the

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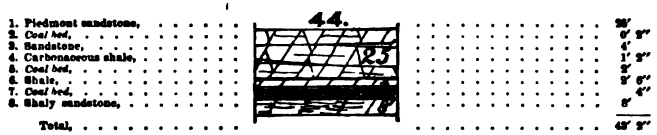
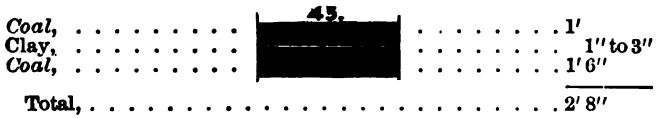
boiler of the tannery has supplied clinker sufficient to macadamize the road from the pit to the tannery. The coal is soft and cakes readily. The *Lower Kittanning coal bed* is not exposed here. At this place the rocks have gained their proper dip.

Cucumber Run. This run enters the Youghiogheny river at but a short distance below the mouth of Meadow run. On the road between the mouth of Meadow run and this stream the *Brookville coal bed* is mined. It is 2 ft. 3 in. thick and yields a very fair coal. The *Clarion coal bed* was opened higher up the hill, but the coal was not good and the opening was deserted.

At barely one eighth of a mile from the river are the falls, which have acquired some local celebrity. There the water falls 37 ft. over the Piedmont sandstone into a picturesque little glen. Under the falls the following section is exposed: (Fig. 44.)



Nos. 2 and 4 are not constant and disappear at only a few yards below the falls. They are similar in character to the fragmentary masses of coal already referred to as occurring in Ohiopyle Falls. Frequently No. 2 is crushed so as to destroy its structure. No. 4 is a rich carbonaceous shale, breaking in blocks and it would no doubt prove to be quite as good for fuel as the coal from some beds belonging to the Upper Productive Coal Series. No. 5, the *Mount Savage coal bed*, seems to be regular and quite good. Near the mouth of Cucumber it has been opened rudely along its face and the structure thus exposed is: (Fig. 45.)



It lies directly under the Piedmont sandstone and only

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one foot of clay separates it from the sandstone below, so that the Nos. 2, 4 and 7 of the falls section are wanting. They are evidently only fragments of the main bed.

The conglomerate is well shown in the bed of the run for a considerable distance above the first road crossing, and just below the forks of the stream the *Brookville coal bed* was once mined. Along the main fork of the run no exposures were seen except near the top of the ridge separating it from Meadow run, where the Saltsburg sandstone was found in great masses. About one fourth of a mile up the north fork the following section was observed on Mr. H. Carson's property: (Fig. 46.)

46.

The coal bed is in three benches, 12, 12, and 6 inches, but there is no shale in the partings. The coal seems to be quite good and comparatively free from sulphur. The ore bed is persistent but unfortunately is so thin as to be worthless. The interesting feature in this section is the disappearance of the thick sandstone which usually appears below the *Clarion coal bed.* This coal bed has been opened by Mr. Carson at another locality further up the run, where it shows the same structure but the roof contains some arenaceous shale.

The Freeport limestone is reached at the head of this fork on Mr. Elijah Briner's property, where it has been mistaken for iron ore. As is frequently the case, the rock is quite ferruginous for a few feet from the crop, but it is certain to become an ordinary limestone at no considerable distance under the hill. The area of the *Upper Freeport coal bed* is almost divided by Cucumber run, if indeed it be not wholly divided. The exposures are quite imperfect along Briner's ridge, toward the run, so that in the absence of close instrumental measurements the matter could not be determined. On the map the outcrop is given as curving round the head of the stream.

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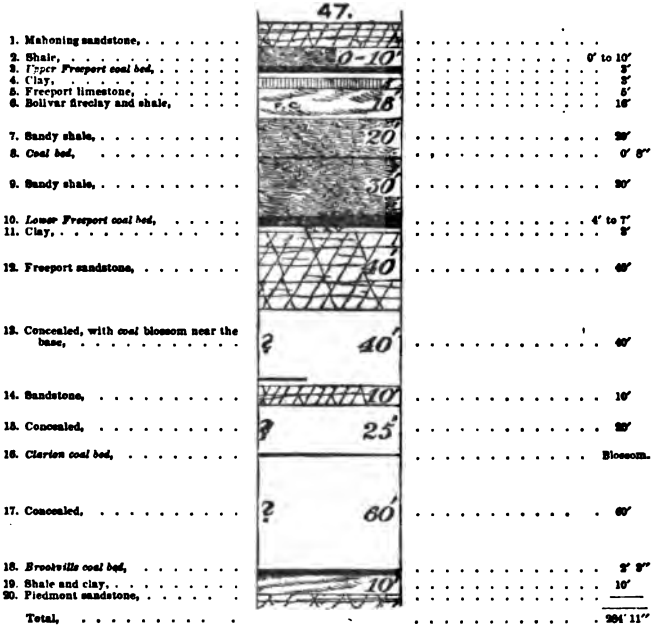
North from Cucumber Run. On the road leading north from Cucumber run, the following section of the Lower Productive Coal Series was obtained: (Fig. 47.)



The Mahoning sandstone is not exposed in detail along the road, but such exposures as do occur show it to be for the most part a flaggy rock, though some of the layers are quite massive and contain some conglomerate.

The *Upper Freeport coal bed* is not opened anywhere between Cucumber run and Jonathan's run, but its blossom was seen in the road as well as on the property of Mr. R. Tharp. Though occasionally 3 feet 6 inches thick, it is usually too thin to be of any value. No exposure of the Freeport limestone in place was found and the thickness given in the section is that observed in an abandoned quarry. Many fragments were seen, which show the rock to be dull bluish-gray, quite compact and of fairly good quality. The Bolivar fireclay is well shown at the roadside as well as at several places on the Tharp and Stewart properties, but the best exposure is on Smalley's spring

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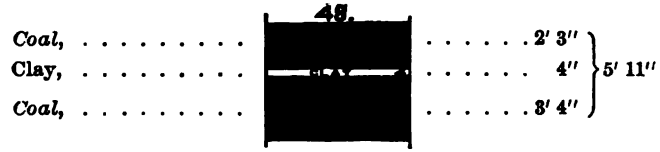
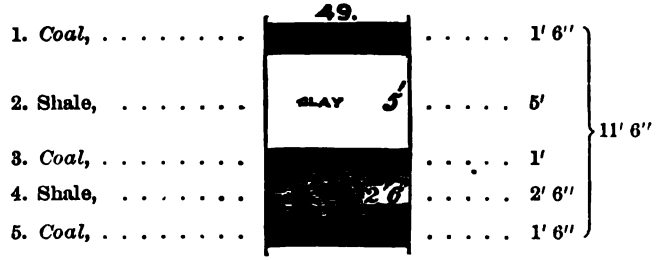
run, where the clay is 8 feet thick, with huge lumps of a handsome iron ore scattered through it. It is precisely similar to the clay from the same horizon at Bolivar.

The *coal bed*, No. 8, was observed only on Smalley's run and it is clearly absent at all the road exposures. It is not the same with that seen at the same horizon on Mr. Joseph Leonard's property, near Meadow run.

The *Lower Freeport coal bed* is mined by Mr. R. Tharp, at whose opening it shows: (Fig. 48.)



The thickness is said to be nearly 7 feet, but this could not be ascertained by actual measurement as the pit contained much water. On Smalley's run there is a deserted opening in the same bed, of which Mr. D. S. Stewart gives the following as the section: (Fig. 49.)



The coal from these openings is said to be very good.

The Freeport sandstone is well exposed on the main road, on the by road leading to Tharp's coal pit and on Tharp's run. The upper portion is flaggy but the lower portion is very compact. The rock contains much feldspar and breaks with a coarse gritty surface. It evidently occupies the greater part of the interval, No. 14, near the base of which is seen the blossom of the *Lower Kittanning coal bed*, already referred to as shown on Meadow run at Mr. Potter's place. It is not fully exposed in this neighborhood, but so far as seen, it is a mass of carbonaceous shale containing

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thin streaks of coal. No. 16, the *Clarion coal bed*, and No. 18, the *Brookville coal bed*, are exposed only by their blossoms and are not mined. The interval between these beds contains much sandstone.

Following the road leading from Cucumber to Jonathan's run, one finds no exposure above the section until at 170 feet above the *Upper Freeport coal bed* the Saltsburg sandstone is reached. It is a massive, compact sandstone, very closely resembling the Pottsville conglomerate as it appears in the southern portion of the Ligonier valley. Many layers are coarsely conglomerate and pebbles are thickly distributed throughout the whole mass. Its fragments cover the hillsides and mingling with those of the Mahoning sandstone, render much of the land unfit for cultivation. The thickness of the stratum is not shown in this vicinity, but it is not less than 45 feet, for a layer of it is shown near the Stone Schoolhouse at 215 feet above the *Upper Freeport coal bed.*

West from the road there are some high knobs rising 500 feet above the *Upper Freeport coal bed* but they afford no exposures.

Near Mr. Nicolay's house on this road, the blossom of a thin coal bed was seen, and at Mr. Totten's house is another, 100 feet below the last and 3 feet thick. At one time the latter was mined, but the opening has been abandoned and the thickness is given on information. This bed is 90 feet above the *Philson coal bed*, which is exposed on the property of Mr. Martin Mitchell near Jonathan's run, where it is 3 feet thick. The bed near Mr. Nicolay's house is embedded in variegated shales and it may represent the *Elk Lick coal bed*, as it is about 260 feet above the *Upper Freeport.*

On Mr. Mitchell's property the Freeport limestone is 18 feet thick and yields excellent lime for agricultural purposes, though near the outcrop it shows a good deal of iron ore. At Mr. Mitchell's quarry the cover of debris is so thick that although 8 feet of stripping has been done, yet the *Upper Freeport coal bed* has not been exposed. The Bolivar fire-clay underlies the limestone and is apparently

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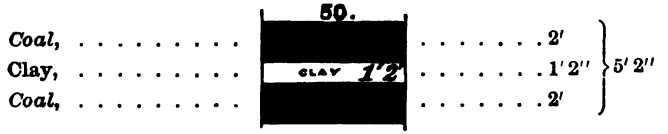
very good. At 50 feet below the limestone Mr. Mitchell has an opening in the *Lower Freeport coal bed* which shows: (Fig. 50.)



The lower portion was not fully exposed, being concealed by mud and water owing to the defective drainage of the pit. The coal is good, comes out nicely in lumps, burns rapidly, but contains much pyrites in streaks from one eighth to one fourth of an inch thick. The middle clay is ordinarily a compact fire-clay crowded with rootlets, but in some portions of the pit it is a very hard carbonaceous shale containing thin streaks of coal and coming out in blocks. At 65 feet below this bed is the *Lower Kittanning coal bed*, which is now concealed but it is said to be 3 feet thick.

At the mouth of Jonathan's run, which enters the river at about three miles below the falls, the U. Mauch Chunk shales are exposed with the Pottsville conglomerate overlying them, and the latter rock is shown along the run to some distance above the stave factory. The bluffs facing this run are singularly free from exposures and few details could be obtained for four miles from the river. The Saltsburg sandstone was seen on the divide between this stream and Laurel run, where its character is the same as on the river hills.

North from Jonathan's run, on the river hill, the Freeport limestone and the *Upper Freeport coal bed* are exposed on the Stewart estate, where the coal is 3 feet thick and is used for burning the limestone. Still further north, on Mr. J. Rush's property, the same coal bed is but 18 inches thick and the limestone has not been reached. Mr. Rush mines the coal by stripping. On the opposite side of the hill, the *Lower Freeport coal bed* (?) is exposed and consists of two benches, each 18 inches thick, separated by from two to three feet of clay. On Mr. A. Stewart's pro-

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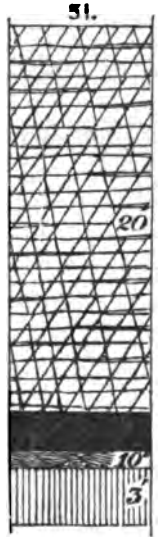
perty, adjoining that of Mr. Rush, the exposure is: (Fig. 51.)

51.



1. Mahoning sandstone, seen, ...	20′
2. *Upper Freeport coal bed*, ...	2′
3. Shale, ...	0′ 10″
4. Freeport limestone, .	3′
Total, ...	25 10″

The limestone is good, and in general character precisely resembles that seen on Mr. Mitchell's property. The coal is in two benches, 5 and 17 inches, separated by 2 inches of clay. On Mr. Rush's property there is a mass of black shale at 25 feet above the coal, which holds a thin coal bed and some lean iron ore.

Descending to Bruner's run, one finds the Pottsville conglomerate in the bed of the stream. At one time, the *Brookville coal bed* was mined here and its thickness is said to be 3 feet, which seems to be the orthodox thickness of all concealed coal beds in this region. No further exposures were found north from this run until at the line of Dunbar township the blossom of the *Upper Freeport coal bed* was seen near Mr. John's residence.

Laurel Run. This stream heads in the northern portion of Stewart township, and flows northwardly through Dunbar township to the Youghiogheny. Its drainage area is small, and for the most part the region drained by it is unimproved, so that little information could be obtained respecting it. For the most part the rocks are below the

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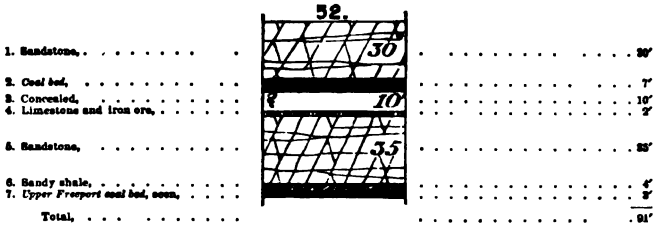
Pottsville conglomerate, though toward the head of one of the forks the Lower Productive Coal Series is caught. Just east from it the *Upper Freeport coal bed* is reached on the high divide between it and Bruner's run.

North and East Side of the Youghiogheny River. At Ohiopyle, the *Brookville coal bed* is exposed in the railroad cut as already described, but thence along the road leading to Springfield, the exposures are unsatisfactory for some distance. The fireclay above the *Clarion coal bed* is imperfectly shown, and at the first summit, about one third of a mile from the river, the *Lower Kittanning coal bed* is shown by its blossom and seems to be merely a carbonaceous shale. The Freeport sandstone was seen near the top of the hill, but thence all is concealed to beyond the first fork in the road, where the *Lower Kittanning coal bed* was again reached.

Where the road crosses Jim's run, the level is a little below the *Lower Kittanning coal bed.* Ascending thence to the summit between this and Stull's run, one sees the Freeport sandstone, the Bolivar fireclay, and the *Upper Freeport coal bed.* At Mr. Weaver's, on the summit, the following section was obtained: (Fig. 52.)

52.


1. Sandstone, ... 30'
2. Coal bed, ... 7'
3. Concealed, ... 10'
4. Limestone and iron ore, ... 2'
5. Sandstone, ... 35'
6. Sandy shale, ... 4'
7. Upper Freeport coal bed, seen, ... 3'
Total, ... 91'

Mr. Weaver once opened the upper coal bed, which he found in two benches, 3 feet each, separated by 1 foot of clay, but the pit was soon abandoned, as the material proved to be only a carbonaceous shale, unfit for fuel. The whole of the mass, Nos. 2, 3 and 4, reminds one of the condition found further north near the Conemaugh river, and the two sandstones may be regarded as representing the Mahoning sandstone. Mr. Weaver has attempted to open the *Upper Freeport coal bed* on the west side, but the dip

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being against him he could not reach the bottom of the bed. A line of springs flows out all round the field on the east side, evidently marking the place of the Freeport limestone. The Bolivar fireclay is well shown here, and is apparently of excellent quality.

At Skinner's run, the Freeport sandstone is reached, and on the summit between that and Bear run the Bolivar fireclay is caught.

In descending to Bear run, one sees the *Lower Freeport coal bed* at Mr. Stull's house, where it rests directly on the Freeport sandstone. This sandstone remains in sight to within one third of a mile of Bear run, and forms a cliff, of which 65 feet are exposed. The rock varies from flaggy to compact. The *Lower Kittanning coal bed* is concealed, but the *Clarion coal bed* is shown in a spring on the old Stull place, and the blossom of the *Brookville coal bed* is exposed at the roadside somewhat nearer the run. The Piedmont sandstone is on both sides of the road for one eighth of a mile, and at the run the Pottsville conglomerate forms bold cliffs alongside of the stream.

Bear run flows on the conglomerate almost to the railroad. At Williamson's old mill, the *Mount Savage coal bed* is one foot thick. Near this mill, the *Brookville coal bed* was once mined by Mr. Williamson, who found it between two and three feet thick and a good coal. Mr. Tissue has opened the *Clarion coal bed* on the hillside above the mill, and has it from 18 to 20 inches thick. The *Brookville coal bed* is easily followed round to the road where it has been opened near Mr. Tissue's house. The *Clarion coal bed* is exposed on the hill-top near by. About a mile east from the road is an outlier of the *Brookville* containing nearly twelve acres. The coal is barely two feet from the surface, and is nearly three feet thick, but, owing to insufficient cover, it is worthless.

On Mr. Emanuel Bisel's property, the *Upper Freeport coal bed* has been opened at several places. One pit below his old residence shows the upper division in two benches, 19 and 15 inches, separated by 1 inch of clay, but the lower division is not exposed. At another pit the bed is 6 feet

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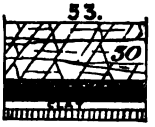
9 inches, the divisions being separated by 1 foot of clay, which is said to vary from 1 foot to 4 feet without materially affecting the thickness of the coal. This bed yields an excellent fuel. Directly below the coal is a compact fire clay with iron ore and an impure limestone, but at a few rods down a little run, the Freeport limestone is exposed and is quarried. Near Mr. Bisel's new house, the following section was found: (Fig. 53.)

53.



1. Mahoning sandstone,	30′
2. Sandy shale,	4′
3. Upper Freeport coal bed,	1′
4. Clay,	6′
5. Freeport limestone,	6′
Total,	51′

The clay is filled with stems and rootlets of *Stigmaria*. The limestone is said to be nine feet thick and to be of very excellent quality. In the road, the upper coal bed of the Weaver section is exposed, but the interval between it and the *Upper Freeport* is filled by bluish argillaceous shale, containing layers of compact fire clay. Between this and Laurel run there are no exposures.

The principal streams, Bear run and Laurel run, were followed up into the mountain, but no exposures in detail were found. The sections are as incomplete as those obtained along the river. Each of these streams cuts down to the Devonian rocks.

4. Dunbar Township of Fayette County.

This adjoins Stewart and Wharton at the north, and is separated from Springfield by the Youghiogheny river. The portion lying within the Ligonier Valley is exceedingly rugged, and by far the greater part is still uncleared. The section reaches from the Saltsburg sandstone to the Devonian rocks.

Along Dunbar creek, which enters the township at the south, near old Centre furnace, the Pocono sandstone is exposed in the creek, and at a little distance below the furnace, the Devonian rocks, with their usual fossils, are shown imperfectly in the creek bed and in the banks.

Along Laurel run and its branches, one finds the Devon-

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ian rocks fairly well exposed near the Youghiogheny river; but at a short distance up the run they pass under, and the Pocono sandstone is exposed in the bed. At old and new Laurel furnaces, the Umbral rocks occur, and contain no inconsiderable amount of iron ore. The workings for these old furnaces have been deserted for many years, and the drifts are in such bad condition that one cannot determine even the number of ore-beds.

Near the river, the *Upper Freeport coal bed* is reached at the border of Stewart township, and it is rudely mined there by Mr. Johns. It resembles the same bed in Stewart township, according to the description given, but no measurement was made owing to the imperfect exposure.

In the same neighborhood two coal beds were seen, which belong below the *Upper Freeport*, but their relations could not be made out. The Saltsburg sandstone occurs on the high divide between Laurel run and Dunbar creek near the southern line of the township, and is as coarse as in Stewart township, near the Youghiogheny river.

In the northern portion of the township, near the crest of the mountain, and in the vicinity of the river, fragments of the Pottsville conglomerate are occasionally seen on the tops of high knobs. One of these, known as Elk rock, from the ancient sculpture on its surface, was an object of much interest. I was unable to find it, and was afterward informed that it has been converted into an excellent article of glass-sand. Fortunately, the other sculptured rock, known as Cow rock, and near Dunbar furnace, does not present a so inviting appearance to the ordinary barbarian. It still remains, though the effects of the weather, and its unfortunate proximity to the wagon road, are rendering some of the markings indistinct.

5. Springfield Township of Fayette County.

6. Salt Lick Township of Fayette County.

These townships lie north from the Youghiogheny river and Stewart township in the order given. Each stretches across the valley from the crest of Laurel ridge to that of

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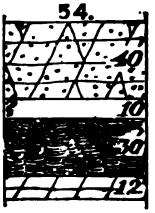
Chestnut ridge. Springfield has a long face along the river and Salt Lick adjoins Donegal township of Westmoreland county. The section in these townships extends from fully 500 ft. above the *Upper Freeport coal bed* to the lowest rocks exposed within the district.

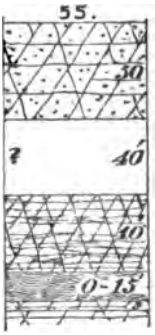
The Youghiogheny River. Along this river the railroad section begins at Laurel run and for the sake of convenience it is carried through the Chestnut ridge gap into Connellsville township as the exposure is not complete on either side of the axis.

In a cut just west of Laurel run the following section was seen: (Fig. 54.)



1. Pottsville conglomerate,	40′
2. Concealed,	10′
3. Dark shale,	30′
4. Compact sandstone,	12′
Total,	92′

At Stewarton station the conglomerate forms a cliff and contains many very coarse layers filled with quartz pebbles. At a short distance below the station is a long side cut near which the section is: (Fig. 55.)



1. Pottsville conglomerate,	50′
2. Concealed,	40
3. Flaggy sandstone,	40′
4. Shale,	0′ to 15′
5. Sandstone, seen,	5′
Total,	150′

No. 3 is the sandstone exposed at the mouth of Laurel run. Here it is flaggy, moderately fine-grained and contains some impressions of plant-stems. Immediately below it is a trace of *coal.* The shale, No. 4, is dark, lead

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or slate colored and contains streaks of iron ore, in all about 9 in. thick, but so scattered as to be of no value. No. 5 is a flaggy sandstone apparently quite argillaceous. A little way in the cut, No. 3 swells and cuts out all of No. 4, but almost immediately the shale comes in again with a thickness of 8 ft.

In a deep cut beyond, the shale again disappears and the two sandstones come together. No. 5 is exposed to the thickness of 20 ft. and, at its top, is conglomerate for 8 ft., the pebbles being of iron ore and from 2 to 6 inches long. No. 5 remains in sight as a poor concretionary rock for some distance below the 68th mile post, the direction of the road almost coinciding with that of the strike. Along this exposure the shale, No. 3, has again become thick and at one locality it contains a thin *coal bed*. The exposure ends at the new tipple of the Springfield mines and shows the sandstone, No. 5, to be not far from 45 ft. thick, but that rock is so irregularly bedded and contains so many pots of shale that its thickness cannot be determined with any degree of accuracy from the exposures.

At this tipple, the sandstone, No. 5, rises finally above the track and at Springfield station, Nos. 1, 2, 3, 4, and 5 are seen in the hill. No. 2 consists largely of sandstone and No. 4 is thin. No. 5 rests on No. 6 a dull irregular shale, 6 to 12 feet thick, under which is No. 7, a *coal bed* showing the following structure:

Coal,	3″
Carb. shale,	1′ 2″
Coal,	2″
Total,	1′ 7″

While below the coal bed is a black fissile shale, 25 ft. thick, which contains numerous plates of iron ore, from half an inch to one inch thick. This is by no means regular but varies in thickness at the expense of a sandstone, No. 9, which is first seen at the station and afterward in a long side-cut reaching to the old tipple of the Springfield mines. It is extremely irregular, has an extreme thickness of not far from 25 ft. and rests on a coarse sandy shale, 12 ft. thick. Underlying this shale is a shaly sandstone like

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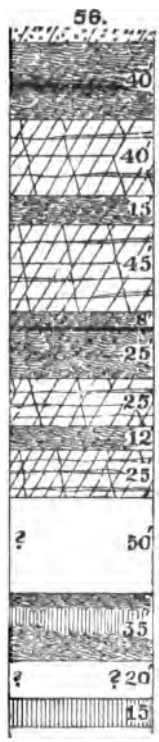
No. 8, which is 25 ft. thick as far as exposed. The middle of this rock is 175 ft. below the conglomerate as measured at the old Springfield tipple. Below this is a concealed space of 50 ft. extending to the 66th mile post, where there is an exposure of dark red shales with thin limestones, in all 35 ft. thick. Below this there are no exposures but the Silicious limestones were seen at the water level on the opposite side of the river. The section of the Umbral rocks so far as exposed along this line is as follows: (Fig. 56.)



1. Pottsville conglomerate,	——
2. Shale, with *coal bed*,	40′
3. Sandstone,	40′
4. Shale,	15′
5. Sandstone,	45′
6. Shale,	8′
7. *Coal bed*,	1′ 7″
8. Shale,	25′
9. Sandstone,	25′
10. Shale,	12′
11. Sandstone,	25′
12. Concealed,	50′
13. Shale and limestone,	35′
14. Concealed,	20 (?)
15. Silicious limestone, seen,	15′
Total,	356′ 7″

The Pocono sandstone comes up from the river bed within sight of Indian creek but only fragmentary exposures were seen until on the west side of Indian creek, where the mass is fairly shown in the hill, though some of the most characteristic portions are concealed. The section as far as obtained is as follows: (Fig. 57.)

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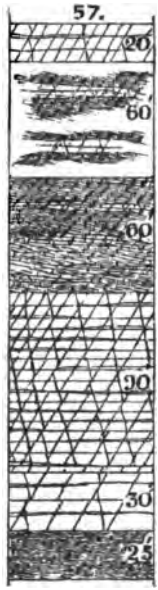

1. Soft olive sandstone,	20′
2. Imp. exposed, but contains much red-gray S. S., and some lead-colored shale, .	60′
3. Shale and shaly sandstone, ...	60′
4. Flaggy sandstone, . .	90′
5. Nodular sandstone, .	4′
6. Compact sandstone, .	30′
7. Sandy shale, ...	25′
Total, ...	289′

The whole thickness is not far from 400 ft. For the most part the sandstones are grayish-white to almost pure white, while the shales are dull slate to lead colored. Near the top of No. 3, is a curious conglomerate layer, one foot thick, made up of small pebbles of iron ore, all of them more or less angular, as though they had been but little exposed to the action of running water. The rock is quite soft and it seems to have been in favor for carving purposes among the ancient inhabitants, as a gigantic hand and an equally gigantic foot carved in relief on fragments of this rock were in possession of the late Mr. Stockton of Uniontown. The hand is still in existence but the fate of the foot is unknown. No. 4 is flaggy throughout and forms a cliff on the west side of Indian creek at its mouth. No. 6 is exposed by a railroad cutting just west from the bridge at that place and occurs in massive layers. It seems to be a good strong stone which would be useful for building purposes. The shale, No. 7, may belong to the Devonian rocks, as it resembles them in color.

The Devonian rocks are well exposed under the arch of the axis; on the east side they pass under the river just

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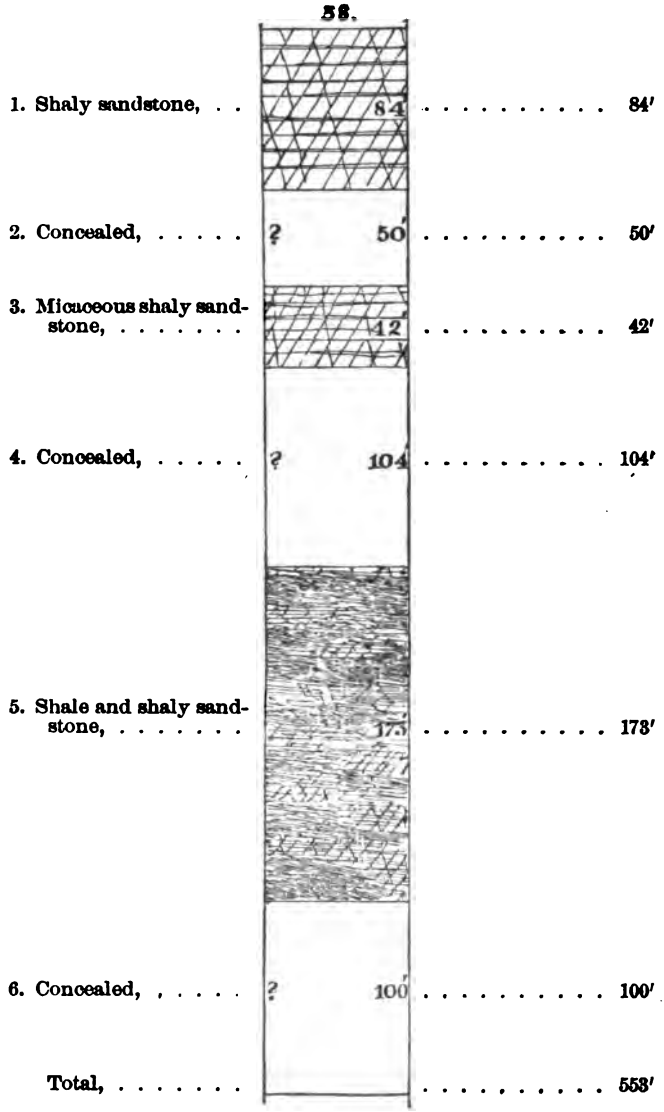
below the mouth of Indian creek and on the west side at little more than three miles above Connellsville. As exposed along the railroad the following is the succession: (Fig. 58.)


58.
1. Shaly sandstone, ... 84'
2. Concealed, ... 50'
3. Micaceous shaly sandstone, ... 42'
4. Concealed, ... 104'
5. Shale and shaly sandstone, ... 173'
6. Concealed, ... 100'
Total, ... 553'

The gaps concealed in the immediate vicinity of the rail-

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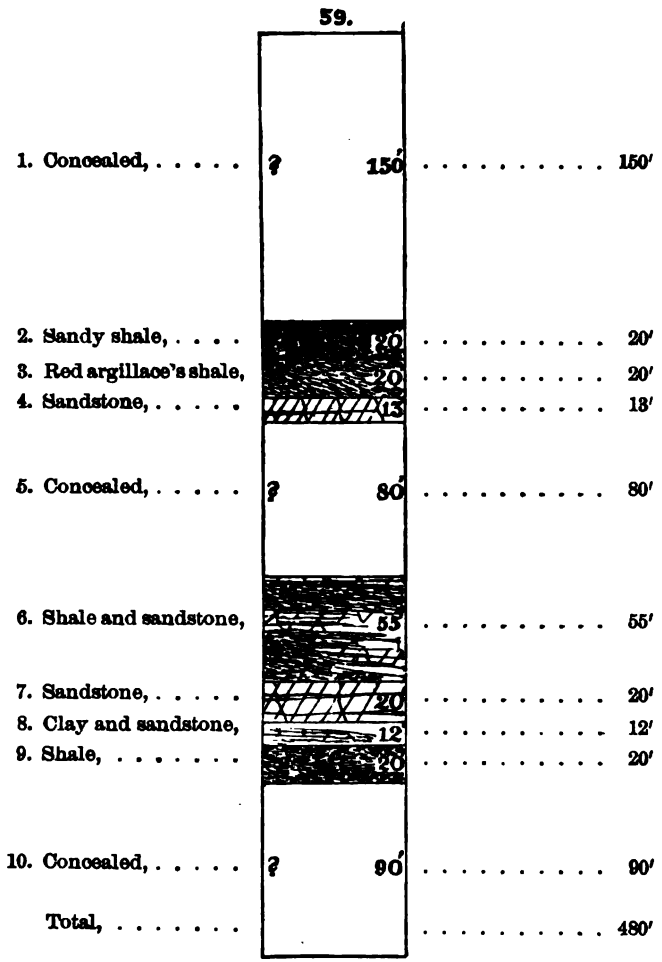
road were filled in the ravines cutting the mountain side and were found to hold chiefly micaceous shale or shaly sandstone, the color varying from red to olive.

On the east side of the axis, beginning at 400 yards east from the 64th mile-post and going westward, the following section was obtained which shows very fairly the character of the rocks, but the thickness is probably inaccurate as the intervals were all estimated: (Fig. 59.)

59.


1. Concealed, ... ? 150′ . . . . . 150′
2. Sandy shale, ... 20 . . . . . 20′
3. Red argillace's shale, 20 . . . . . 20′
4. Sandstone, ... 13 . . . . . 13′
5. Concealed, ... ? 80′ . . . . . 80′
6. Shale and sandstone, 55 . . . . . 55′
7. Sandstone, ... 20 . . . . . 20′
8. Clay and sandstone, 12 . . . . . 12′
9. Shale, ... 20 . . . . . 20′
10. Concealed, ... ? 90′ . . . . . 90′
Total, ... 480′

Some indistinct exposures go to show that the interval,

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No. 5, is filled in great measure with rock closely resembling that found in Nos. 4 and 6. These contain a red micaceous sandstone of irregular structure, largely argillaceous, with red to olive or dark brown shales alternating with layers of the sandstone. In these two intervals the sandy layers contain great numbers of fossil mollusks. No. 7 is a bluish gray rock, very compact, such as would be useful as a building stone. No. 8 contains some fossils and No. 9 shows some pots of sandstone.

The anticlinal of Chestnut ridge crosses the Youghiogheny river very near the 63d mile-post or somewhat more than a mile and a quarter below the mouth of Indian creek. At probably one third of a mile below that point there begins a long cut which continues almost to the 62d mile-post and affords the following section: (Fig. 60)

1. Shale and sandstone,	20′
2. Shale,	22′
3. Sandstone,	12′
4. Dark clay,	12′
5. Shale and sandstone,	25′
6. S'dst'e, like quartzite,	2′
7. Sandy shales,	80′
Total,	173′

No. 1, which is seen immediately below the 62d mile-post, is very badly contorted as though it had been subjected to some lateral thrust before the overlying rock was deposited on it. A very similar condition exists in No. 8 of the section above, which at one locality describes a very close downward curve, the two sides being in contact, but neither No. 7 nor No. 9 is affected by the disturbance in No. 8. No. 3 of this section is crowded with fucoids, some of which are very large but they are all characterless. No. 4 contains great numbers of mollusks, most of which are so ill-preserved that their generic characters can be determined only with difficulty. It is probable that at no inconsider-

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able distance from the outcrop, good specimens may be obtained. Some of the sandstones of No. 5 contain many fucoids while others are crowded with characteristic Chemung fossils. Several of the sandy layers are quite conglomerate. No. 7 consists of red to brown and olive sandy shales in layers, 3 to 6 feet thick, separated by hard compact layers 1 to 2 feet thick. The harder layers are reddish-gray, micaceous and contain many Chemung species.

The higher layers of the series are imperfectly exposed between the 61st and the 62d mile-post, but Nos. 1 and 3 contain great numbers of fucoids and occasionally show a *Rhynchonella* or *Spirifer*. The top of the series passes under the railroad at the 61st mile-post, where the Pocono sandstone comes down to the track on the west side of the axis. This sandstone remains in sight for half a mile and has a thickness of 375 feet. For 60 feet at the base it shows occasional layers of conglomerate but thence to the top it is comparatively fine-grained, and passes imperceptibly into the Silicious limestone of the Umbral. No portion of the mass contains any fossil remains other than a few fragments of carbonized wood. The sandstone is light-gray throughout and for the most part it is quite compact.

The Silicious limestone of the Umbral is reached at the quarry near the 60th mile-post. The section of the Umbral group here in the vicinity of the railroad is: (Fig. 61.)

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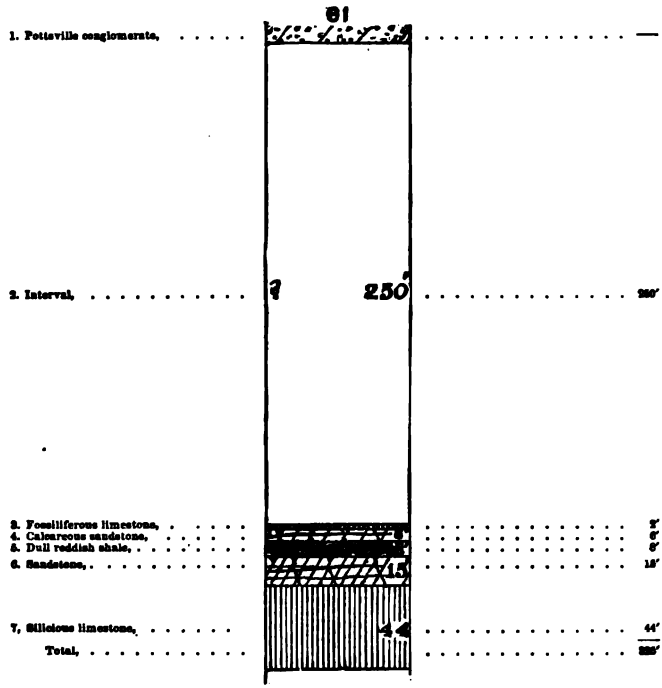

The Mauch Chunk shales and the higher limestones are wholly concealed. About a mile north from the railroad, on the Connellsville and Springfield pike, the highest limestone is 120 feet below the conglomerate, the interval being filled with red shale, holding the iron ores of this group. No details respecting these ores can be obtained and the mines are in the same condition as when they were visited in 1876.

The sandstone, No. 6, is conglomerate for 9 feet from the base, and contains many lumps of the Silicious limestone. The rock is calcareous throughout. The upper portion of the Silicious limestone is slaty and irregular, but the lower portion is compact, light blue and has a conchoidal fracture. On the freshly exposed surface no evidence of bedding is seen, but on the long weathered surface the rock is shown to be very curiously cross-bedded. As the experiment of using this material for street pavement in Pittsburg has proved successful, this quarry is worked extensively.

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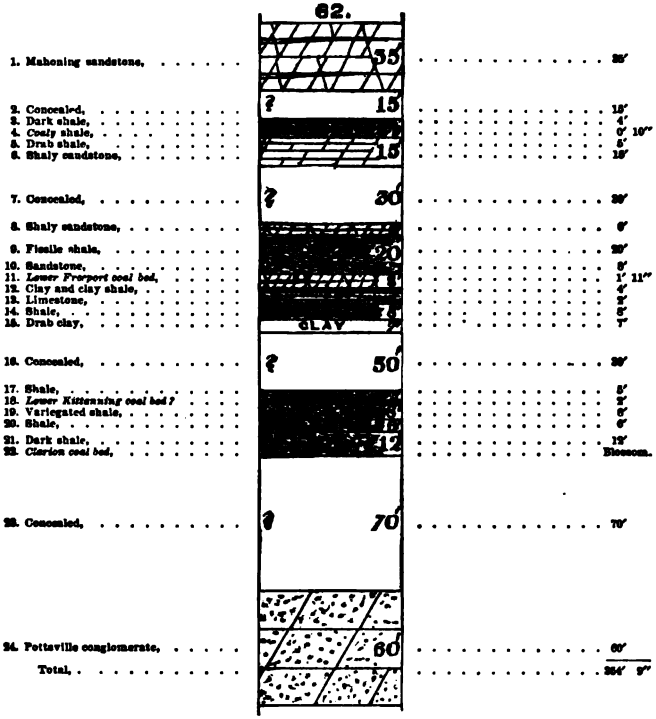
The Pottsville conglomerate reaches the track at the sand-works and within a short distance the Lower Productive Coal Series are reached. The section obtained along the railroad is as follows:


62.
1. Mahoning sandstone, ... 35' . . . . . 35'
2. Concealed, ... ? 15 . . . . . 15'
3. Dark shale, ... 4'
4. Coaly shale, ... 0' 10"
5. Drab shale, ... 5'
6. Shaly sandstone, ... 15 . . . . . 15'
7. Concealed, ... ? 30 . . . . . 30'
8. Shaly sandstone, ... 6'
9. Fissile shale, ... 20 . . . . . 20'
10. Sandstone, ... 6'
11. Lower Freeport coal bed, ... 1' 11"
12. Clay and clay shale, ... 4'
13. Limestone, ... 2'
14. Shale, ... 6'
15. Drab clay, ... CLAY 1' . . . . . 1'
16. Concealed, ... ? 50 . . . . . 50'
17. Shale, ... 5'
18. Lower Kittanning coal bed? . . . . . 2'
19. Variegated shale, ... 0'
20. Shale, ... 6'
21. Dark shale, ... 12 . . . . . 12'
22. Clarion coal bed, ... Blossom.
23. Concealed, ... ? 70 . . . . . 70'
24. Pottsville conglomerate, ... 60 . . . . . 60'
Total, ... 264' 9"

The *Upper Freeport coal bed* is concealed at the railroad, but it is opened near by at Mr. Swank's pit, as described in the report for 1876. The Freeport limestone is clearly absent here as is also the Bolivar fireclay. The *Lower Freeport coal bed* is well exposed as a double bed, the benches being 18 and 4 inches separated by one inch of clay. The limestone below this bed is ferruginous, dark-gray on the fresh surface and non-fossiliferous. No. 18 is broken by thin partings, but seems to be a very good coal. The conglomerate is merely a coarse sandstone, quite soft and free from pebbles. The Mahoning sandstone goes under the track near the 59th mile post.

Between the 59th mile post and White Rock Station, a

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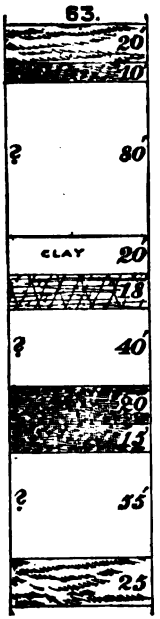
partial section of the Lower Barrens was obtained, as follows: (Fig. 63.)



1. Shale and clays,	20′
2 Shale,	10′
3. Concealed,	80′
4. Variegated clay,	20′
5. Flaggy sandstone,	18′
6. Concealed,	40′
7. Dark shale,	20′
8. Variegated shale,	15′
9. Concealed,	55′
10. Variegated shale and clay,	25′
Total,	303′

In No. 1 there is a worthless limestone near the base. No. 5 is at the horizon of the Saltsburg sandstone, the base of which should be somewhere in the concealed interval, No. 6. The Morgantown sandstone is not reached by the section.

Returning now to Springfield township, the first stream one meets is

Indian Creek. This stream heads in Donegal township of Westmoreland county at the west base of Laurel ridge, and, flowing irregularly southwest, passes through Salt Lick and Springfield, reaching the Youghiogheny river at the east base of Chestnut ridge. Passing up this creek, one crosses in succession the Vespertine, the Umbral and the Conglomerate, reaching the Lower Coals near the site of the old St. John furnace; but no satisfactory exposures occur below the mouth of Mill run, a large tributary, which rises in Laurel ridge and enters Indian creek at about three and one-half miles from its mouth. The *Upper Freeport coal bed* lies in patches on both sides of this stream but the

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larger area is on the west and south sides and stretches over into Stewart township. In this, the coal is mined by Mr. Williams, Dull and others. On the opposite side and just north from Mill Run post office, the coal is mined by Mr. J. Bigham at whose pit it varies from 3 ft. 10 in. to 4 ft. and has a persistent parting, 2 to 3 inches thick at 18 inches from the bottom. It is very brittle and by far the larger part of the coal comes down as slack. Southeast from Mill run, between it and the township line, the Mahoning sandstone was seen on the road leading from Springfield to Falls city, and the *Philson coal bed* was seen near the run on the same road. The *Upper Freeport coal bed* crosses this road very near the run and is mined by Mr. Dull. At a mile and a half from this road the outcrop of the Conglomerate crosses the run and near the head of the stream a small patch of the Devonian rocks is exposed. The Lower Carboniferous rocks are imperfectly shown.

North from the run along this road the *Upper Freeport coal bed* is not exposed but the blossom of the *Philson coal bed* was seen very near Mr. Elijah Kooser's house, near which the coal was once mined. The thickness of this bed is reported to be four feet. The *Upper Freeport* is mined on a little branch of Indian creek near this road by Mr. Silas Prinkey at whose pit it shows:

Coal,	8′
Clay,	2′
Coal,	1′ 6″
Total,	6′ 6″

The Freeport limestone is not exposed. The coal is roofed by shale and at a short distance higher fragments of the Mahoning sandstone were seen. On another fork of this little run the Mountain limestone is quarried for agricultural purposes. The Mauch Chunk shales are badly exposed and the Silicious limestone rests directly on the Pocono sandstone.

The Mauch Chunk shales are exposed on the clay pike near Mr. Haight's house and near by, the Mountain limestone has been quarried for burning into lime. Further east the Pocono sandstone crosses the road and is extraordinarily white. The Devonian rocks do not seem to cross the pike

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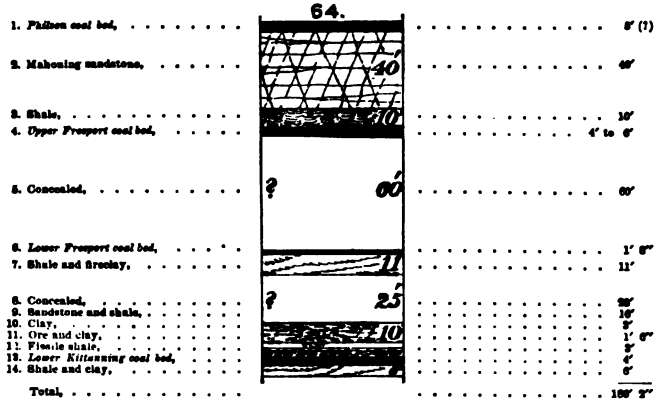
and the Pocono evidently passes over the crest unbroken. Between the outcrop of the red shales and the creek opposite Springfield there are no rocks which couldbe identified.

Laurel run enters the creek about a mile above the pike-crossing. It is formed by the union of the main and middle forks with Bucks run at less than half a mile from Indian creek. Fayette furnace, near the mouth of Bucks run, is a massive stone stack which went out of blast in 1841. On the three streams forming Laurel run the following section was made out: (Fig. 64.)

64.


1. Philson coal bed, ... 5' (?)
2. Mahoning sandstone, ... 40'
3. Shale, ... 10'
4. Upper Freeport coal bed, ... 4' to 6'
5. Concealed, ... 60'
6. Lower Freeport coal bed, ... 1' 6"
7. Shale and fireclay, ... 11'
8. Concealed, ... 25'
9. Sandstone and shale, ... 10'
10. Clay, ... 3'
11. Ore and clay, ... 1' 6"
12. Fissile shale, ... 3'
13. Lower Kittanning coal bed, ... 4'
14. Shale and clay, ... 6'
Total, ... 169' 3"
40
10
60
11
25
10

The *Philson coal bed* is imperfectly exposed by a spring run in a hill back from the furnace and is said to be 5 ft. thick. It rests directly on the Mahoning sandstone, which is a coarse irregular rock, which contains some pebbles and in some portions is crowded with impressions of plant stems.

The *Upper Freeport coal bed* is mined on the furnace property and varies in thickness from 4 to 6 feet. The roof portion is 1 ft. thick and consists of very hard, richly carbonaceous shale, which cleaves like the common cannel of this region. The remainder of the bed shows some irregular partings, of which only that at one foot from the top is persistent. The coal is tender, prismatic and cokes well, but it contains a very appreciable proportion of sulphur. The rock immediately overlying the coal here is concealed, and there is said to be a very fair iron ore almost directly under it. The Bolivar fireclay was not seen here and the Freeport limestone has not been opened.

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The *Lower Freeport coal bed* is imperfectly exposed in the road leading from Mrs. Roger's house to the run, but it was opened in a spring near the house, where it showed the thickness given and yielded a very fair coal. The fireclay below it is exceedingly good, is non-plastic, flint-like in fracture, mottled and for the most part of a bluish-gray color. It is well exposed in the road near the house, as well as for two thirds of a mile up Buck's run and for more than a mile and a half along the main fork of Laurel run.

The *Lower Kittanning coal bed* was seen on Bucks run immediately above the furnace stack, where it shows

Black shale,	1′ 6″
Coal,	2′ 6′
Total,	4′

The shale is richly carbonaceous and is a good fuel, though it has a large proportion of ash. The coal is impure, contains much pyrites, is quite hard and is digged with difficulty.

The ore above the *Lower Kittanning coal bed* is variable and, as exposed near the stack, it shows two layers each from 2 to 4 inches thick. It seems to have been an important source of supply for the furnace, as benchings begin at one fourth of a mile up the run and continue for a like distance. At 25 feet below the coal is another deposit of ore, no longer exposed at any locality, but which seems to have been benched quite as extensively as the other. The shales directly below the coal contain many lumps of fine-grained ore, which is of good quality. Its place could not be determined, but it may be the same with that of the lower benchings.

At about a mile up the main fork of Laurel run, the fireclay of the section was seen on Mr. G. Work's property, and at very nearly the proper distance below it is a coal bed which is evidently the *Lower Kittanning;* but at 12 feet above this coal bed is a bed of limestone, which was quarried years ago to supply flux for the furnace. As the quarry has been abandoned for thirty years, the exposure is incomplete, but the bed is said to be 8 feet thick. Some portions are quite ferruginous and the rock represents the

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Upper Kittanning limestone. It is certainly absent at Fayette furnace, where, as is so often the case, it is replaced by shale carrying iron ore. The coal is roofed by a thin sandstone, and has the following structure:

Coal,	1′ 0″
Clay,	1″ to 3″
Coal,	1′ 6″
Total,	2′ 9″

The structure, therefore, is quite different from that seen at the furnace.

Along the several streams uniting at the furnace, no coal bed lower than the *Lower Kittanning* was seen. On Bucks run the Upper Mauch Chunk shales are imperfectly shown at about a mile above the furnace, and a coal bed 20 inches thick is associated with them. They are seen at about the same distance up the middle fork, as well as at Porterfield's saw mill on the main fork. At the last locality the Silicious limestone and the Pocono sandstone are exposed. Small patches of the Devonian rocks occur on Bucks run and the main fork of Laurel. No iron ores have been discovered under the Pottsville conglomerate, which, however, nowhere appears as a cliff along these streams. As the whole region was diligently explored while the furnace was in blast, there seems to be good reason for supposing that the upper members of the Umbral ore group are wanting here. A lean hematite occurs just above the Mountain limestone, but it was not used at the furnace.

The synclinal crosses Laurel run very near the junction of the several forks.

In the vicinity of Springfield and northward along Indian creek to near the township line the openings in the *Upper Freeport coal bed* are quite numerous. South from that village, on the road leading to Falls City, are openings belonging to Mr. Eicher and Mr. Sol. Davis, while there is another at barely one half mile southeast from the village. At these openings the structure of the bed is:

Coal,	1′ 3″
Coal,	1′ 6″
Clay,	2″
Coal,	1′ 4″
Total,	4′ 3″

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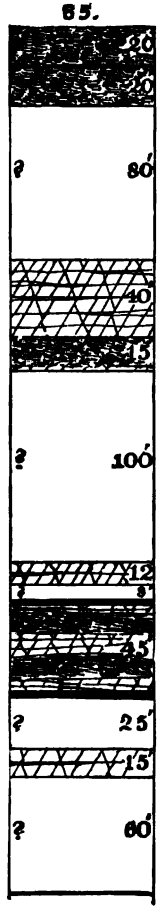
With the top bench in no case fully exposed. In all, the top division is apt to be slaty, very hard, and much like slaty cannel. The other benches are prismatic, and yield very tender coal. At Mr. Eicher's pit the Freeport limestone has been seen, but at the others it is wholly concealed.

Springfield is built on a high hill, which catches some of the highest rocks found in this region. Beginning at the top of the hill and descending to the creek the following section was obtained: (Fig. 65.)

65.



1. Shale,	20′
2. *Elk Lick coal bed*,	1′
3. Variegated shale,	20′
4. Concealed,	80′
5. Saltsburg sandstone,	40′
6. Shale,	15′
7. Sandstone,	8′
8. Imperfectly exposed	100′
9. Sandstone,	12′
10. Concealed,	8′
11. *Philson coal bed*,	3′
12. Mahoning sandstone and shale,	45′
13. *Upper Freeport coal bed*,	4′
14. Concealed,	25
15. Sandstone,	15′
16. Concealed,	60′
17. *Lower Kittanning coal bed*, in creek,	?
Total,	451′

The red shales underlying the *Elk Lick coal bed* on the

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hill top, back from the village, show a brilliancy of color rarely seen in the Lower Barren series. The coal varies from 10 to 14 inches, and seems to be quite good. The place of the Green Fossiliferous limestone is concealed. The Saltsburg sandstone is well exposed in the road leading from Springfield to the creek. It is soft, readily breaking down on exposure, and in parts is very coarsely conglomerate. Some of the layers are coarser than the Pottsville conglomerate on Laurel ridge, and quite as coarse as any layers of that rock at any point within the district. The same sandstone is well shown on a run which flows on the north side of Springfield, and enters the creek at a little way above that village, where it crops out, the soil contains vast numbers of the pebbles. Its position in relation to the *Upper Freeport coal bed* is the same as in Stewart township beyond the Youghiogheny river. The interval between this and the *Philson coal bed* is very imperfectly exposed, but it seems to hold a thin coal bed at between 90 and 100 feet above the *Philson*. The latter bed is not far from 3 feet thick, and makes a broad blossom in the road. The Mahoning sandstone is a flaggy, irregularly bedded sandstone, and reaches down quite to the *Upper Freeport coal bed*. The shale, which usually intervenes, having wholly disappeared.

The *Upper Freeport coal bed* is mined by Mr. Schultz and Mr. Gallentine at a little distance from the road and varies not much from 4 feet. The *Lower Kittanning coal bed* was once stripped out of the creek-bed and the Upper Kittanning limestone was once quarried on the opposite side of the stream. The coal is said to be nearly 5 feet thick but nothing could be ascertained respecting the limestone as the quarry was wholly filled up with debris.

Along Indian creek, Mr. J. F. Campbell's opening in the *Upper Freeport coal bed* was seen about one mile above Springfield. It shows the coal in three benches 13, 13 and 27 inches, the partings being well defined but containing no slates. The top bench is very bony and is left in the pit to strengthen the roof; the other benches yield a prismatic and very tender coal, which cannot be brought down in lumps. Between the coal and the Mahoning sandstone

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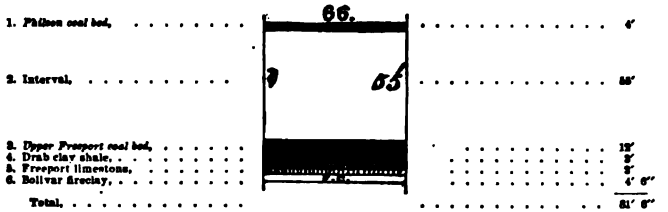
is an interval of 20 feet, filled with shale, which becomes sandy toward the top.

Somewhat further up the creek the following section was obtained on Mr. A. J. Rose's property: (Fig. 66.)


66.
1. Philson coal bed, ... 6"
2. Interval, ... 65'
3. Upper Freeport coal bed, ... 12"
4. Drab clay shale, ... 2'
5. Freeport limestone, ... 2'
6. Bolivar fireclay, ... 4' 6"
Total, ... 81' 6"

The *Philson coal bed* has been mined by Mr. Rose; it shows a clay parting, 1 to 2 inches thick, which is black, very hard and contains occasional streaks of coal. The coal from this bed is quite hard but can be mined without blasting. As a fuel it is thought to be superior to that from the *Upper Freeport*. The latter bed as exposed in the section is very badly broken up and reminds one of a section of the same bed in Randolph county of West Virginia as given in report KK, p. 87. The mass is shown for 12 feet, but without doubt the thickness is greater. It consists largely of carbonaceous shale with streaks of coal varying from one tenth of an inch to 10 inches in thickness. Mr. Rose asserts that the whole mass can be used as fuel. Perhaps it can, if there are enough hands about the house to carry out the ashes. The limestone below the coal is argillaceous and needs to be burned with much care as it is liable to fuse if burned with haste. When properly burned it yields a lime which is said to be very good for agricultural purposes. The fireclay seems to be very good.

From this point to the township line there are no exposures along the creek, but on Poplar run the *Philson coal bed* is exposed near the road to Springfield. Its thickness could not be ascertained from the exposure, but the coal must be good for the strippings are extensive.

Passing into Salt Lick township along the creek, one finds no exposure until opposite Sparks' tannery, where the *Upper Freeport coal bed* is mined by Mr. Sparks. The bed is in three benches, 8, 13 and 20 inches thick, which

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are separated by knife-edge partings. The top bench is a cannel shale containing vast numbers of *Spirorbis carbonarius*. The coal from the other benches is quite soft, but it is thought to be clean and serviceable fuel.

On Back run, which enters the creek near the tannery, a thin coal is mined, which may be the *Lower Kittanning*. It varies little from 2 feet 3 inches and yields good coal. The Freeport limestone was seen on this run, but its thickness could not be ascertained from the exposure. No exposures in detail were found along this run, but the hollow cuts deeply into the mountain and should reach the Devonian rocks.

Between Sparks' tannery and the mouth of Champion run the *Upper Freeport coal bed* is above the creek and is mined, but the openings show no important variation from those already given. The same is true of the openings on Champion run, excepting that belonging to Mr. Stahl, which shows the coal 4 feet thick, without the usual top bench of carbonaceous shale. On this property 15 feet of shale intervene between the coal and the Mahoning sandstone, while above the latter is a *coal bed* associated with an impure limestone. This limestone slakes badly, contains much iron, and it may represent the Johnstown ore bed. At 50 or 60 feet higher is another coal bed, said to be 3 feet 6 inches thick, which has been mined to a slight extent.

Above the mouth of Champion there are only deserted openings in the *Upper Freeport* and the lower coals are not exposed. The Freeport limestone was observed at but one locality. The coal and limestone remain above the creek to the township line, but on the east side they have been removed by erosion for the greater part of the distance.

Along the face of Chestnut ridge there are few exposures within these townships, and such as do occur are so far from being satisfactory that no identifications of the coals seen could be made. For the most part, the conglomerate reaches almost to the crest of the mountain along the ridges separating the streams, while the Lower Carboniferous rocks are exposed in the ravines. No portion of the Devonian rocks was observed at any locality north from the Youghiogheny river.

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CHAPTER XI.

WESTMORELAND COUNTY.

7. *Donegal Township of Westmoreland County.*

This, the southern township of the Ligonier valley in Westmoreland county, adjoins Salt Lick of Fayette. Indian creek heads near its northeast corner, and flows along the base of Laurel ridge southward to the county line. On the west side, Four-mile creek heads near the old West Newton and Mount Pleasant pike, and flows northwardly along the base of Chestnut ridge into Cook township. The synclinal between the two ridges crosses the Mount Pleasant pike almost midway between Donegal and Jones' mills, and the exposed section extends from 450 feet above the *Upper Freeport coal bed* to the Pocono sandstone.

Beginning at the northeast and coming down the ridge past the Lutheran church to Indian creek, one rides all the way in the Lower Barren Series. At a short distance from the Felger road, which is the boundary between this and Cook township, one crosses a black shale, much like that associated with the Black Fossiliferous limestone, and near the creek-bottom reaches the Mahoning sandstone.

Here Mr. Montgomery Scott has the Black Fossiliferous limestone opened in a field northwest from his house. The rock is not fully exposed, but it is a double bed, the upper portion being a hard argillaceous limestone, and the lower an almost equally hard calcareous shale, which is crowded with stems of *crinoids*. At 40 feet below this, is an old coal pit, which was worked many years ago, but nothing is known now respecting either the thickness or the quality of the coal. A coal blossom was seen in the road at 120 feet below the limestone which may represent the *Philson coal bed*. Above it is some non-plastic fireclay of inferior quality.

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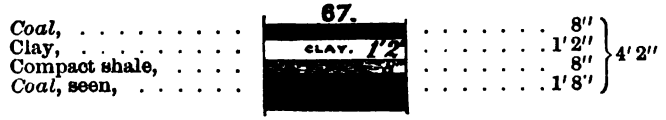
At a little distance further up the creek, Mr. Scott has opened the *Upper Freeport coal bed*, which shows: (Fig. 67.)



Between the coal and the Mahoning sandstone there is shale 5 feet thick. The compact shale of the section is exceedingly hard, comes out in blocks and in the wall of the pit it may be mistaken for the ordinary cannel shale. The coal is very fair, but the bed is too thin to repay working.

The broad bottom here is in many places a spongy bog and on its surface are many little hummocks under which water from springs has accumulated. This whole bottom is covered by a deposit of bog iron ore, which was mined many years ago for Fountain furnace on Camp run. On the opposite side of the run and at a considerable distance above the stream, Mr. Scott has opened the *Clarion coal bed*, which shows 5 ft. 5 in. of solid coal, unbroken by any seam of slate, though there are three distinct partings, of which the most marked is at two feet from the top. The coal is irregularly laminated and in some places seems to be crushed though still solid. There are no clay veins or horsebacks. In the main entry the coal suddenly disappears at two hundred and fifty feet from the mouth of the pit and is replaced by a confused mass of coal, slate and sandstone. This foreign matter is known to be at least 16 feet thick, but it has not been followed further. Mr. Scott thinks that the trouble results from a slide of the hillside. While this is not impossible, yet it is hardly probable that a so extensive slide could occur without inflicting serious injury on the coal, such as is nowhere apparent in this mine. It is much more likely that this is an old channel-way, eroded in the coal-marsh and afterward filled during flood. The sandstone belonging with the *Clarion coal bed* is present here and its fragments are liberally distributed over the surface. Above this point there are no connected

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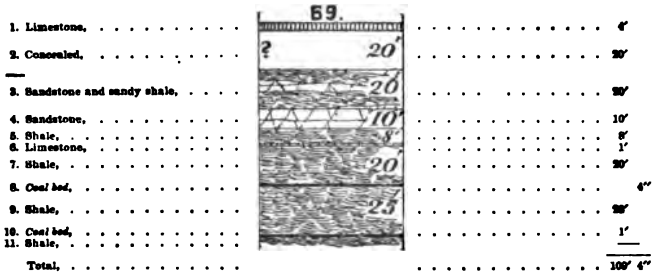
exposures along the run. The Silicious limestone is reached at the Felger road.

About a mile below Mr. Scott's house, the *Upper Freeport coal bed* is opened on Mr. Barclay's property, where it shows: (Fig. 68.)

A structure very similar to that observed at Mr. Scott's opening. On the same property another coal bed was once opened at about 50 feet below the *Upper Freeport.* On the next property a limestone, 4 ft. thick, is quarried and the following section was found below it on Camp run: (Fig. 69.)


69.
1. Limestone, ... 4'
2. Concealed, ... 20'
3. Sandstone and sandy shale, ... 20'
4. Sandstone, ... 10'
5. Shale, ... 8'
6. Limestone, ... 1'
7. Shale, ... 20'
8. Coal bed, ... 4"
9. Shale, ... 23'
10. Coal bed, ... 1'
11. Shale, ...
Total, ... 109' 4"

Just above where the road crosses Camp run, a *coal bed* 4 ft. thick, was struck in a well and a *coal* blossom has been ploughed up in the field opposite, just above the sandstone of No. 4, so that the place of the coal bed could be somewhere in the concealed interval above. This coal bed is the *Lower Kittanning* and the limestone above it is the Upper Kittanning, but the *Upper Kittanning coal bed* has not been discovered. The rest of the section resembles nothing seen elsewhere. The limestone, No. 6, is evidently local as it was not seen at any other exposure of its horizon. No. 7 contains a coal bed one half inch thick. The other coal beds could not be identified as no exposures were found further up the run until the Pottsville conglomerate was reached.

The outcrop of the *Upper Freeport coal bed* remains on

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the west side of the creek to the old pike, but there it crosses to the east side and the Mahoning sandstone is well shown just beyond the bridge. The blossom of the *Philson coal bed* has been ploughed up in a field above. At a little distance south from the pike the creek turns southward and the outcrop again crosses it. The Mahoning sandstone goes under at a little way above Jones' Mills. Thence to Donegal the road lies in the Lower Barren Series and there are no connected exposures.

On the headwaters of Four-mile run the *Philson coal bed* has been mined within one mile of Donegal. It is said to be about 3 ft. thick. It remains in sight to the mouth of a little run coming in from the west, where the *Upper Freeport coal bed* has been opened by Mr. Harman. The pits at this place were in bad shape when visited and no measurements could be made. On the same run the *Philson coal bed* is mined by Mr. Keyser, at whose pit it is 2 ft. thick and yields good coal. Near the head of the run, Mr. Howard quarries the Black Fossiliferous limestone, which is unusually compact and clean, so that it will make a lime good enough for agricultural purposes. It is 1 ft. 3 in. thick and is closely crowded with fossils. The overlying black shale is but partially exposed.

At 80 feet higher in the hill Mr. Howard has made a trial opening in a *coal bed* which he finds to be from 8 to 10 inches thick. The Morgantown Sandstone is exposed at the head of the run and huge blocks of it lie scattered over Mr. Howard's fields. It occurs in place on Mr. Hair's property, adjoining this.

On the main run, the Black Fossiliferous limestone is exposed in the hill opposite Mr. Harman's place and it has been quarried to a slight extent to supply agricultural needs. The *Upper Freeport coal bed* goes under the run at about a mile further down and thence to the township line the road lies in the Lower Barren Series. Along the face of Chestnut ridge the Conglomerate forms the principal rock and the outcrop of the *Upper Freeport coal bed* lies far up toward the crest. The exposures are very unsatisfactory.

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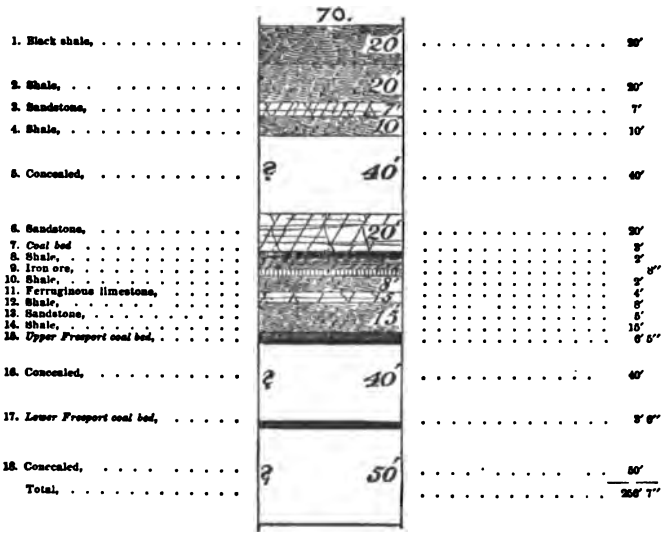
8. Mount Pleasant Township of Westmoreland County.

This adjoins Donegal at the west and the portion belonging to the Ligonier valley embraces only the eastern slope of Chestnut ridge, but owing to the extensive erosion by Jacob's creek it is unlike most of the mountain slope, for much of it is good farming land. The double axis of Chestnut ridge is seen here, though the eastern axis is very feeble, amounting only to an interruption of the dip. The best exposures were found along the old clay pike leading from Greensburg to Donegal, and the section extends from the Morgantown sandstone to the Mountain limestone.

On the clay pike at the summit of the ridge there are many fragments of the Pottsville conglomerate, which seems to cross the axis almost unbroken. No further exposures were seen until near the old schoolhouse, about a mile and a half from the Mount Pleasant pike. Between this and the road leading to Four-mile run the following section was obtained: (Fig. 70.)


70.
1. Black shale, 20 20'
2. Shale, 20 20'
3. Sandstone, 7'
4. Shale, 10 10'
5. Concealed, ? 40' 40'
6. Sandstone, 20 20'
7. Coal bed 2'
8. Shale, 2'
9. Iron ore, 8"
10. Shale, 2'
11. Ferruginous limestone, 4'
12. Shale, 6'
13. Sandstone, 5'
14. Shale, 15 10'
15. Upper Freeport coal bed, 6' 6"
16. Concealed, ? 40' 40'
17. Lower Freeport coal bed, 3' 6"
18. Concealed, ? 50' 50'
Total, 255' 7"

The *coal bed*, No. 7, is the only one seen above the *Upper Freeport*, and the error on p. 265 of KK, where two

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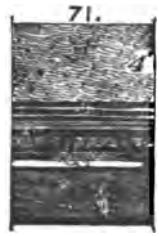
beds are given as occurring in this position, was due to the fact that the effect of the new axis in changing the dip had not been ascertained when the measurement was made, and indeed the existence of the eastern axis was not even suspected at that time. The *coal bed*, No. 7, is well exposed in the road between the residences of Mr. J. Freeman and Mr. Jesse Stairs, where an excavation shows it to be 3 feet thick. It was found in the well at Mr. Freeman's house, and just beyond that it goes under the run. The same bed is shown in the road leading to Mr. Freeman's opening in the *Upper Freeport coal bed.* The black shale, No. 1, was first seen at the grave yard, but thence almost to the Mount Pleasant pike it is constantly in sight. On the crest of the divide between Jacob's creek and Four Mile run the Morgantown sandstone is exposed. The coal bed, No. 17, is mined near the schoolhouse by Mr. Miller, at whose pit it is a solid mass of coal without any slate partings.

On Jacob's creek the *Upper Freeport coal bed* is mined by Mr. J. Freeman, at whose opening the following measurement was made:* (Fig. 71.)

71.



1. Shale,	4″	
2. Slaty coal,	1′ 1″	
3. Black clay and slaty coal,	7″	
4. Coal,	3″	
5. Black slate,	6″	6′ 8″
6. Coal,	3″	
7. Black slate,	8″	
8. Ferruginous clay,	4″	
9. Coal,	3′	
Total,		10′ 8″

At some distance inside the pit, No. 3 becomes 14 inches, and is a jet black brittle slate without bedding, and having a fracture like cannel. It does not burn, but breaks into small pieces when thrown on the fire. No. 9 alone is mined, so that the bed is known as the "3 foot coal." This lower division is in three nearly equal benches, separated by very thin but persistent partings. Pyrites occurs as nodules in

* For the sake of completeness a few notes from Report KK are reproduced here.

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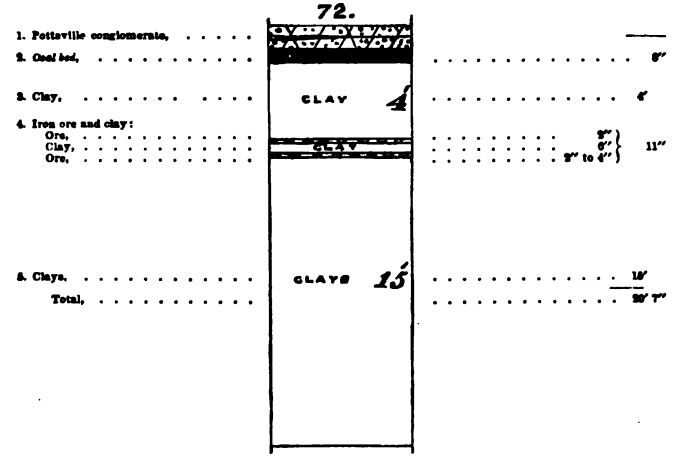
the bottom bench, and in the clay immediately below the coal. The parting above this bed is frequently pyritous. The coal burns freely, and in the grate shows little tendency to cake. It is used extensively throughout this section, and is the same with that mined by Mr. Jesse Stairs.

Fifteen feet below this coal bed, at Mr. Freeman's opening, is the Freeport limestone, which has been mistaken for an iron ore. A lean ore is associated with it.

Near the saw-mill, or about a mile below Mr. Freeman's coal pit, the following section was obtained: (Fig. 72.)



The coal bed associated with the Big Bottom ore bed, and seen further down the creek on the western side of the axis, cannot be far below the bed of the stream here. The clay No. 3 contains some nodular iron ore; the ore of No. 4 has the peculiar structure observed in the Kidney ore of the Umbral group at Lemont furnace in Fayette county, as well as at several other localities. It is evidently a good ore. At a little way below the saw-mill the Big Bottom ore bed is in the stream, and its *coal bed* is seen near by.

On a run entering Jacob's creek, nearly half a mile above the saw-mill, Mr. T. B. Mays made an exploratory opening in the Big Bottom ore bed. The ore seemed to be of good quality, as shown in the pit, and had the unusual thickness of three feet. But analysis showed that the bed had lost

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its character as an iron ore and had degenerated into an impure limestone containing only a low percentage of metallic iron. At one time the coal bed above this ore was mined near Mr. Mays' house. Near the mouth of the pit, the coal is 3 feet thick and seems to be solid, without slate partings.

Between the saw-mill and the limestone quarry, where the axis crosses, there is abundance of bog iron ore. At the quarry, the Mountain limestone is exposed as follows: (Fig. 73.)

73.

1. Limestone, in thick layers,	18′
2. Argillaceous limest'e,	20′
3. Compact limestone,	2′
Total,	40′

No. 1 is very pure, and yields a lime which, for whiteness, compares favorably with any lime in the market. Mr. Freeman burns it extensively, and it is sold to the farmers for use on their farms. Its effects on the land are very marked. The whole mass is fossiliferous, but specimens occur in greatest numbers in No. 2, which is in thin layers. The species are not numerous, but the specimens are fine and in prodigious quantity.

No rocks are exposed along Jacob's creek.

9. Cook Township of Westmoreland County.

This lies directly north from Donegal and stretches wholly across the valley. The Loyalhanna rises in the southeastern corner and flows northward along the base of Laurel ridge, while on the western side, Four-mile run enters from Donegal and flows along the base of Chestnut ridge. The exposed section extends from within two hundred feet of the *Pittsburg coal bed* to the Pocono sandstone.

The Loyalhanna is formed by the union of two streams heading under the ridge, which is the southern boundary of the township, and separates the waters of Indian creek from those of the Loyalhanna. The more important of these is known as White Oak run.

On Laurel run, which enters White Oak not far from the

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township line, the Silicious limestone and the Mauch Chunk shales are well exposed near the Felger road. On the same run the *Upper Freeport coal bed* is mined by Mr. Snyder and Mr. Lyon. At Mr. Lyon's opening the coal varies little from 4 feet, but at Mr. Snyder's it is from 3 feet 6 inches to 4 feet. The bed shows no persistent partings, but has many binders of pyrites, which make the coal very tender. This coal burns handsomely, but is destructive of stoves, owing to the presence of so much sulphur. In some of the old pits now deserted, the overlying shale frequently formed horse-backs, and cut out 7 or 8 inches of the coal, and in the same pits there are clay veins, 3 to 4 inches wide, which threw the coal and curled it for some distance on each side. As the entries have all fallen shut no examination of these could be made. The coal crops out on the Felger road about half a mile east from the cross-roads. Overlying it is shale, 8 feet, above which is the Mahoning sandstone, fully 60 feet thick, of which great blocks lie scattered over the fields in the vicinity.

In a field west from Mr. Lyon's house the *Philson coal bed* has been ploughed up, and a trial pit showed it to be 18 inches thick. At 5 feet below it is much rotten limestone, but the bed is not exposed. Below the *Upper Freeport coal bed* there is plastic fireclay for 5 feet, but thence to the run there is no exposure. In digging a well, Mr. Snyder, who lives on the Felger road, near the outcrop of the *Upper Freeport*, passed through the *Upper Kittanning* limestone and *coal.*

The outcrop of the coal crosses the road at a little way south from Laurel run, but a small area of the coal and the Mahoning sandstone is crossed by the road between Laurel and Powder Mill run.

On Powder Mill run, which enters White Oak at about one fourth of a mile south from Weaver's grist-mill, the *Lower Kittanning coal bed* passes under near the first bridge, but it is fairly well exposed on the run about midway between Mr. Ankney's house and that of Mr. Leacock. At one time it was mined here, and was found to be 3 feet 6 inches thick. Underlying it is a blue fireclay 7 feet thick,

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resting on a peculiar sandstone, which has been mistaken for an iron ore. Just above Mr. Leacock's house, the massive sandstone belonging below this coal bed is exposed. Above the coal for 50 feet there is nothing but shale, and the place of the Upper Kittanning limestone is marked by much sandy iron ore which is worthless. On this hill there is a small area of the Mahoning sandstone and the *Upper Freeport coal bed*, but the coal has not been mined.

Above Mr. Leacock's saw-mill there are no good exposures on this run. The Pottsville conglomerate is imperfectly shown at about half a mile further up, and near this exposure there is an extensive deposit of bog iron ore. Just below Mr. Jonathan Shawley's house, three miles from Weaver's grist-mill, the Mountain limestones are shown. At one quarry a layer 7 feet thick is worked, but at Mr. Shawley's the limestone is in thin layers scattered through 40 feet of shale. The Silicious limestone is first reached at about 300 yards above Mr. Shawley's house, and at a short distance further the Pocono sandstone is exposed.

Returning to White Oak run, one finds the *Upper Freeport coal bed* exposed by its blossom on the hill above Weaver's grist mill. On the same hill the *Lower Freeport* is similarly exposed, and immediately behind the mill the *Upper Kittanning coal bed* is seen in the bank. It is exposed also at a little distance further down the run at a quarry in the Upper Kittanning limestone. This limestone is very poor, and the lime obtained from it can be used only for the coarsest purposes. On the opposite side of the run, and at some distance from the road, the *Lower Kittanning coal bed* is mined by Mr. I. Weaver, who has it from 3 feet 6 inches to 4 feet thick, and of very fair quality. It is slaty on top, and has some bony coal in the middle, but the whole of it can be used for fuel. The Upper Kittanning limestone lies in lumps on the hill-top. At 8 to 10 feet below the coal is a sandstone the same with that already referred to as occurring on Powder Mill run. It is curiously twisted, is excessively hard, has a fracture like quartzite, and contains many slender casts of stems enveloped by thin films of coal. It is well exposed in the meadow between

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Mr. Weaver's house and the road, and is three or four feet thick.

At a little way below Weaver's mill the forks of the Loyalhanna unite. Just above the junction Mr. Ankney has an opening in the *Lower Kittanning coal bed*, which is similar to other openings already mentioned. The outcrop of the *Upper Freeport coal bed* lies west from the creek until at half a mile south from the township line it crosses the stream to the east near Mr. McClune's house. At that place there is a deserted opening in this coal bed, showing a thickness of four feet. Mr. McClune mines the *Lower Kittanning coal bed*, which is 3 feet 6 inches, and yields a coal which is thought to be superior to that from the *Upper Freeport*, as it is not so injurious to stoves.

Linn's run rises in this township and enters the Loyalhanna in Ligonier. At the township line the Pottsville conglomerate is in the bed of the stream, and forms bold cliffs on each side. For the most part it is a moderately coarse-grained rock; some coarse blocks are occasionally seen, but the great mass shows no conglomerate features. The thickness is not easily ascertained, but it cannot be far from 100 feet. Underlying it is a mass of red shale with some sandstone, the whole very imperfectly exposed. At Robbins' mill, three miles above Mechanicsburg, the Mountain limestone is quarried by Mr. Rector. The pure portion is in all not far from 16 feet thick, and occurs in thin layers interstratified with calcareous shale. Below this are red shales, probably 50 feet thick, under which is the Silicious limestone.

On Four-mile run there are few exposures. At several places a thin coal bed, probably the *Philson*, is mined in a small way, but in the few hollows on the mountain side no exposures were found, and the existence of the *Upper Freeport coal bed* seems to be unknown. No coal blossom was seen anywhere along the face of the mountain within this township, and the outcrop of the *Upper Freeport coal bed* as placed on the map is wholly conjectural.

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10. LIGONIER TOWNSHIP OF WESTMORELAND COUNTY.

This township, which lies directly north from Cook, stretches across the valley, and has the crests of Laurel and Chestnut ridges as its boundaries at the east and west. The Loyalhanna flows northward along the base of Laurel ridge to near the central line, where it turns westward and flows in that direction until it passes beyond the limits of the township. The section extends from 110 feet above the *Pittsburg coal bed* to the Devonian rocks, and the synclinal of the trough crosses the Loyalhanna at Ligonier.

Along the Bedford pike and Loyalhanna creek. The Pottsville conglomerate comes down to the creek at the mouth of the Loyalhanna gap in Chestnut ridge, and is in the stream bed where the pike crosses, about four miles west from Ligonier. Debris conceals everything on the face of the mountain, and even in the creek-bed there are no exposures for some distance above this locality. At a short distance below the first bridge over the creek, an old opening in the *Upper Freeport coal* was seen alongside of the pike, and the Mahoning sandstone is well shown resting directly on the coal. At a short distance further east, and on the level of the creek-bottom, the same bed is mined, and shows 4 feet 2 inches of coal underlying 7 feet of shale. For one foot at the top the coal is quite inferior, and the bed seems to contain a good deal of pyrites throughout, but it is said to be liked for fuel. The roof is made of tender shale and is very insecure. The Freeport limestone is present here, and at a little way further down the creek the *Lower Freeport coal bed* is exposed. The interval between the two coal beds is about forty feet. The upper bed goes under the stream very near the bridge.

Along the pike, from this locality to Ligonier, the exposures are fragmentary, and being in the Lower Barrens are very unsatisfactory. The black shale associated with the Black Fossiliferous limestone is exposed in a cutting nearly three miles west from Ligonier, and on the next hill is a fine exposure of variegated shale. A distinct though not strong anticlinal crosses the pike at about two miles west from Ligonier.

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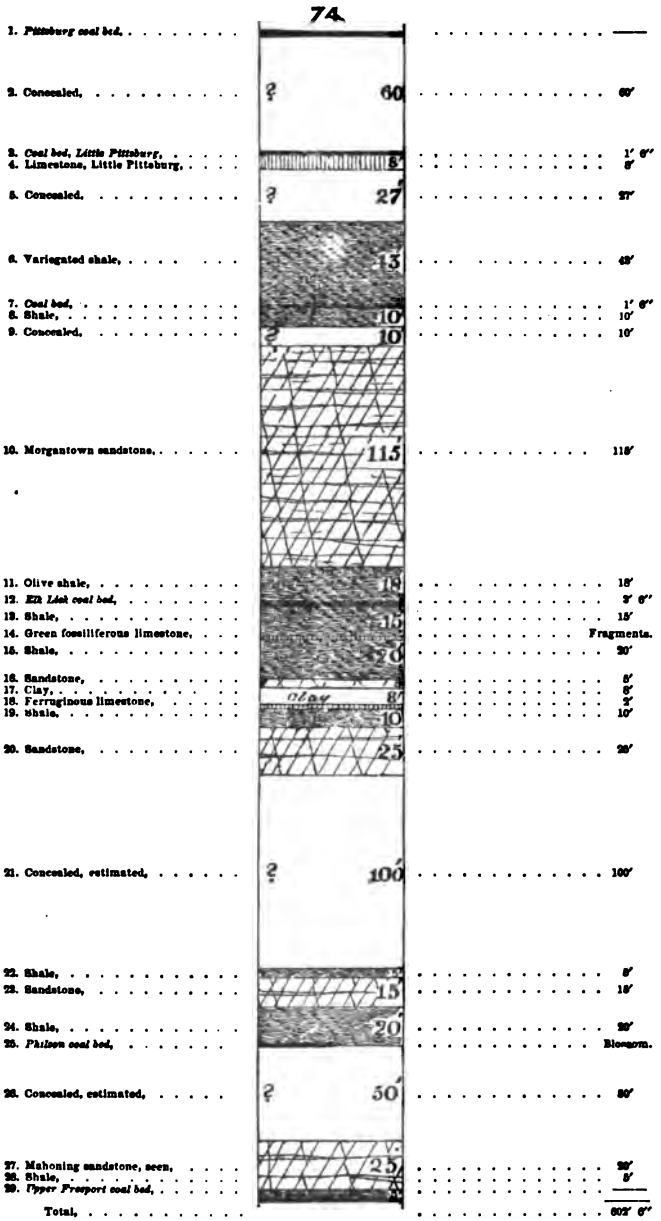
74
1. Pittsburg coal bed, —
2. Concealed, ? 60 60′
3. Coal bed, Little Pittsburg, 1′ 6″
4. Limestone, Little Pittsburg, 8 8′
5. Concealed, ? 27 27′
6. Variegated shale, 13 43′
7. Coal bed, 1′ 6″
8. Shale, 10 10′
9. Concealed, ? 10 10′
10. Morgantown sandstone, 115 118′
11. Olive shale, 18 18′
12. Elk Lick coal bed, 3′ 6″
13. Shale, 15 15′
14. Green fossiliferous limestone, Fragments.
15. Shale, 20 20′
16. Sandstone, 6′
17. Clay, clay 6 6′
18. Ferruginous limestone, 2′
19. Shale, 10 10′
20. Sandstone, 25 28′
21. Concealed, estimated, ? 100 100′
22. Shale, 8′
23. Sandstone, 15 18′
24. Shale, 20 20′
25. Philson coal bed, Blossom.
26. Concealed, estimated, ? 50 80′
27. Mahoning sandstone, seen, 25 28′
28. Shale, 5′
29. Upper Freeport coal bed,
Total, 602′ 6″

On the hill opposite Ligonier, on the south side of the

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Loyalhanna, there is a small area of the *Pittsburg coal bed*, in which is an opening belonging to Mr. Smith. The hill rises about 50 feet above the coal, but there are no exposures of the rocks. The coal is good, and the structure of the bed is similar to that shown in other openings to be described. The exposures on this hill, and on those further east along the pike, afford a very fair section of the Lower Barrens, as given in figure 74.

That portion of the section extending from the *Pittsburg coal bed* to the base of the Morgantown sandstone is exposed in the hill opposite Ligonier, the coal being 275 feet above the creek at one eighth of a mile below the grist-mill at Ligonier. The coal bed, No. 3, is partially exposed at the lime quarry below Mr. Smith's house, and it was once opened at the head of a little spring run entering the creek at the mill-dam. Its thickness is given on information, as the blossom only is now exposed. The bed seems to be persistent at all points where the hills are high enough to catch it.

The limestone, No. 4, is quarried on Mr. Smith's property. It is light blue on the weathered surface, which is very rough. No exposure of it was found in the spring run referred to, but the bed has been opened on the opposite side of the hill, where it is of excellent quality and yields excellent lime. The same bed has been ploughed up on the top of McIlvaine's hill, half a mile east from Ligonier. The rocks below this to the Morgantown sandstone are exposed only in the spring run, where the shale, No. 6, is triple, consisting of black and drab shale, 19 ft., sandstone, 4 ft. and yellow shale 20 ft.

The *coal bed*, No. 7, appears in the spring run to be about one foot thick, but many years ago the father of Col. J. McFarland mined it in a field below the Smith limestone quarry and found it to be 18 inches thick. Col. McFarland says that there is a limestone associated with it, but whether above or below the coal he cannot say. The place of the coal is concealed by a slide in the field, but in the spring run the limestone is certainly absent for the exposure is complete.

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The concealed space, No. 9, should include the ore-bed found at Oak Grove furnace, at a little more than 150 feet below the *Pittsburg coal bed.*

The Morgantown sandstone, No. 10, shows an extraordinary thickness. It is an irregular mass and is not perfectly exposed in the hill opposite Ligonier. The top for 40 feet is rudely flaggy, below that for 40 feet there are alterations of flaggy sandstone and sandy shale, the latter occasionally becoming argillaceous, while the lower portion, which is well shown along the creek for from one-fourth of a mile below the mill to some distance above the bridge, is a flaggy sandstone, quite hard, blue and micaceous. It is quarried near the bridge to supply flagging stone for Ligonier.

The shale underlying the Mahoning sandstone is not exposed in the creek bank at Ligonier but is well shown beyond the first road turning north from the pike, east from Ligonier. The *Elk Lick coal bed* was mined in the creek bed by means of a coffer-dam. The thickness is said to be 4 ft. and tradition affirms that the coal is of excellent quality, admirably adapted to smiths' use. This coal bed is shown in the bluff on Mr. Seaton's property, barely half a mile below Ligonier and there it is 3 ft. 6 in. thick. The blossom of the same bed is exposed on McIlvaine's hill above the pike at half a mile east from Ligonier, where it is little more than a rich cannel shale and is associated with a thin plate of iron ore one inch thick.

The place of the Green Fossiliferous limestone was not accurately determined on the pike. Fragments of that rock were found at the place of No. 14 and the bed itself is not likely to be more than a few feet higher in the hill. No. 18 is a compact layer of ferruginous limestone, but it is evidently too lean to be used as an ore. The same bed occurs about half a mile east from Ligonier, so that it is measurably persistent. The sandstone, No. 16, is somewhat shaly and is crowded with minute fragments of carbonized wood.

The sandstone, No. 20, is reached at the second road east from Ligonier, where a little run crosses the pike. It is

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quarried on both sides of the hollow as well as far up on the next hill. The upper portion is flaggy but the lower part is very irregular and cross-bedded, so that it is of little value. The rock is brownish-gray, and mostly fine-grained but it contains some ferruginous layers, which are quite conglomerate.

The concealed interval, No. 21, is given by estimation as no direct measurement can be made, but the thickness as given is not far wide of the truth. The Black Fossiliferous limestone occurs somewhat above the middle of this interval, it being, as ascertained elsewhere, about 100 feet above the *Philson coal bed.* On the east side of Zimmerman's run, the black shale associated with this limestone has been ploughed up. No. 23 is exposed on the west side of Zimmerman's run, two miles east from Ligonier, and being of very fine grain, it has been quarried there for the manufacture of grindstones.

Just east from this run the blossom of the *Philson coal bed* has been ploughed up in a field and at a short distance up the run the bed is exposed having a thickness of one foot.

At Dr. Burnett's house, east from Zimmerman's run, the *Upper Freeport coal bed* was struck in digging a well and it is reported as being in all about 8 ft. thick. The interval between it and the *Philson coal* is not far from 80 feet.

Here the course of the Loyalhanna is changed. Thus far the stream has flowed from the east but now its course to the head is from the south. Laurel run, which flows from the east, enters the Loyalhanna here and is followed by the pike to Laughlinstown.

On the south side of Laurel run the *Upper Freeport coal bed* is mined by Dr. Burnett at a short distance above the mouth of the stream, and the exposure at the mouth of the pit is as follows: (Fig. 75.)

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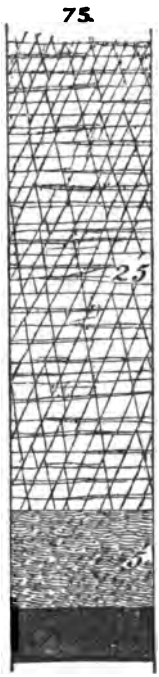

1. Mahoning sandstone, seen, ... 25'
2. Shale, ... 5'
3. *Upper Freeport coal bed*, ... 2' 9"
Total, ... 32' 9"

No. 3, as far as exposed, is as follows:

Coal, ... 1' 11"
Clay, ... 1"
Coal, ... 9"
Total, ... 2' 9"

But the exposure is evidently incomplete and the bed is said to be somewhat more than 3 ft. thick. The upper portion is prismatic at the top but regularly laminated below, while the lower bench is slaty. The bed rises rapidly eastward and within one-fifth of a mile it is at the summit of the hill. The Freeport limestone is not exposed on this hill but it is said to be present. Nearer Laughlinstown the *Upper Freeport coal bed* is mined at a little distance north from the pike and at Laughlinstown the *Upper Kittanning coal bed* is exposed with a thick limestone below it.

Along the pike east from Laughlinstown there are few exposures and all of them are imperfect. Not far from that

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village, fragments of a massive sandstone, which on Laurel run is 190 feet below the *Upper Freeport coal bed*, are found thickly strewn over the surface but the rock is not shown in place. This sandstone is the same with that which in Report KK was called the Piedmont sandstone. Underlying it is an important bed of iron ore which was benched extensively to supply Washington furnace, of which the abandoned stack is still visible at a little way off the pike.

Underlying the shales containing the ore-bed is a coal, imperfectly exposed in the drain. It is the *Brookville coal bed*, the same with that hesitatingly identified with the *Mount Savage coal bed* in Report KK. The distance from this bed to the Pottsville conglomerate was estimated at 20 feet, but this estimate may be slightly too large or too small as the exact limit of that conglomerate could not be determined.

Huge fragments of the Pottsville conglomerate appear at a few yards above the coal and at the toll-house they cover the surface. At a little distance further the bottom of that rock is reached, but the line was not accurately fixed as the rock does not appear in place along the road, while the density of the growth on the hill-side prevents one from seeing more than a few feet ahead, so that exploration is almost impossible. This conglomerate is only moderately coarse in grain and its thickness is not far from 100 feet.

The Mauch Chunk shale is not exposed along the pike. Exploratory openings have been made in search of the Umbral ores but they seem to have been unsuccessful. The Silicious limestone is reached at about a mile above the toll-house, but it is poorly exposed; beyond it to the summit the lower rocks are occasionally shown.

Laurel Run. On this run the section shown in Fig. 76 was obtained.

The section down to No. 22 is exposed on Mr. Robert Hall's farm, near the junction of the two forks of the run. On the hill below the junction the *Upper Freeport coal bed* was mined twenty-five years ago, by Mr. L. C. Hall, who was operating Washington furnace at that time. The opening is now closed, but the bed is said to vary from 3 feet 6

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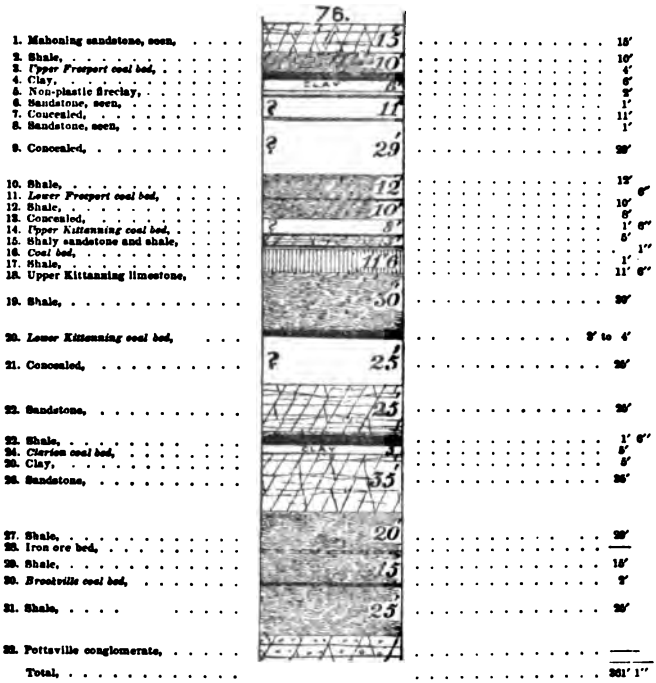
76.
1. Mahoning sandstone, seen, 15'
2. Shale, 10'
3. Upper Freeport coal bed, 4'
4. Clay, 6'
5. Non-plastic fireclay, 2'
6. Sandstone, seen, 1'
7. Concealed, 11'
8. Sandstone, seen, 1'
9. Concealed, 29' 28'
10. Shale, 12' 12'
11. Lower Freeport coal bed, 6"
12. Shale, 10' 10'
13. Concealed, 5' 5'
14. Upper Kittanning coal bed, 1' 6"
15. Shaly sandstone and shale, 5' 1"
16. Coal bed, 1'
17. Shale, 11'6 11' 6"
18. Upper Kittanning limestone, 3
19. Shale, 30 30'
20. Lower Kittanning coal bed, 3' to 4'
21. Concealed, 25' 25'
22. Sandstone, 25 25'
23. Shale, 1' 6"
24. Clarion coal bed, 2'
25. Clay, 5'
26. Sandstone, 35' 35'
27. Shale, 20 20'
28. Iron ore bed,
29. Shale, 15 15'
30. Brookville coal bed, 2'
31. Shale, 25 25'
32. Pottsville conglomerate,
Total, 361' 1"

inches to 4 feet, and to yield excellent coal. This opening is on the main eastern outcrop, and the same bed is caught in the hills along the run down to Dr. Burnett's opening, a distance of fully two miles and a half. Another extensive mine in this bed was worked by Mr. L. C. Hall, back from Laughlinstown, but that opening too has been deserted for many years. Mr. Armour, of Laughlinstown, has some pits on the opposite side of the hill, in which the coal varies from 3 to 4 feet, and is in high repute as a fuel.

No. 5 is the Bolivar fire clay. It was seen only on Mr. Hall's property. An analysis of this clay is given in another chapter. The *Lower Freeport coal bed* was seen only at the same locality, where it has been exposed by a slide. Its place is concealed at all the other localities examined.

The *Upper Kittanning coal bed* is well exposed on Mr. Hall's hill, as well as on another hill just east from the Waterford road. It remains in sight along the run almost

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to Laughlinstown, going under the stream, near the grist-mill, above the village. It shows little variation in thickness, and yields a fair coal, but is not mined.

The Upper Kittanning limestone varies greatly both in thickness and quality. As exposed in the hill belonging to Mr. Hall, it shows

Limestone,	1 6″
Shale,	1′
Limestone,	9′

The upper bed is a compact layer, splitting so readily that posts of regular shape have been made from it, but it is of uneven composition, containing some thin and very hard layers, so that the weathered surface is grooved. This portion makes good lime, but must be burned carefully. The lower portion is a massive dull-gray to blue rock, evidently quite argillaceous, and containing great numbers of small mollusks. It contains also many lumps of limestone, which are clearly fragments of the Mountain limestone. This portion of the bed is burned into lime only with difficulty, as it tends to fuse.

This limestone is persistent along the run below this quarry, and is digged by Mr. Armour near Laughlinstown, but there it is better in quality than at Mr. Hall's. The thickness is nearly the same as that given in the section, but at some other places it is little more than 4 feet.

On the hill east from the Waterford road this limestone is wanting, but the *Upper Kittanning coal bed* is fully exposed at the proper distance above the *Lower Kittanning coal bed.* Instead of the limestone there is here a shale containing a large quantity of nodular iron ore, which must be by no means insignificant, for the strippings reach 14 feet of cover, and extend for fully one third of a mile along the face of the hill. The cover having become so thick that benching was unprofitable, a drift was run for a long distance into the hill. As this drift is 8 feet high, there is reason to suppose that no bed of ore was found, and that the benching was done to procure the nodules scattered through the shale. The ore is said to have been hauled to Hillsview furnace on the border of Fairfield township, six

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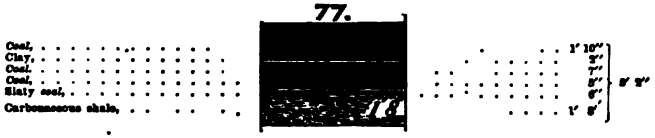
or seven miles away; but unless the lumps are more closely packed under the hill than they are in the exposed portion, it is doubtful whether mining would be profitable in the present condition of the iron market, although the ore seems to be a very good carbonate. In color it closely resembles the Honeycomb ore, as shown at the mines of Lemont furnace in Fayette county.

The *Lower Kittanning coal bed* is exposed on Mr. Hall's property, where it is from 3 ft. 8 in. to 4 ft. thick and is divided nearly midway by a thin parting. The top for 8 inches is quite slaty but below that to the slate parting the coal improves and is a good fuel. Below the parting the coal is soft, clean and very rich in volatile combustible matter. This bed was once opened on the Waterford road near Mr. Hall's house and its blossom is exposed in the field near the old ore diggings. Mr. Armour has an opening near Laughlinstown, which shows the same character as that belonging to Mr. Hall. The bed passes under the run at somewhat more than half a mile above Laughlinstown.

The sandstone, No. 22, is exposed in the run at a short distance above Mr. Hall's opening in the *Lower Kittanning* and remains in sight for fully one third of a mile. It is coarse-grained, occurs in thick irregular layers and is not likely to be of any value.

The *Clarion coal bed* is exposed alongside of the run at a short distance above the junction of the forks. An attempt was made here to open the bed but the work was not finished. As far as shown the structure of the bed is: (Fig. 77.)

77.



The carbonaceous shale is said to be one foot thicker than is shown. The coal seems to be of only moderately good quality. No other exposure of this bed was seen in the vicinity.

No. 26 is imperfectly shown in the bluff but the mass is

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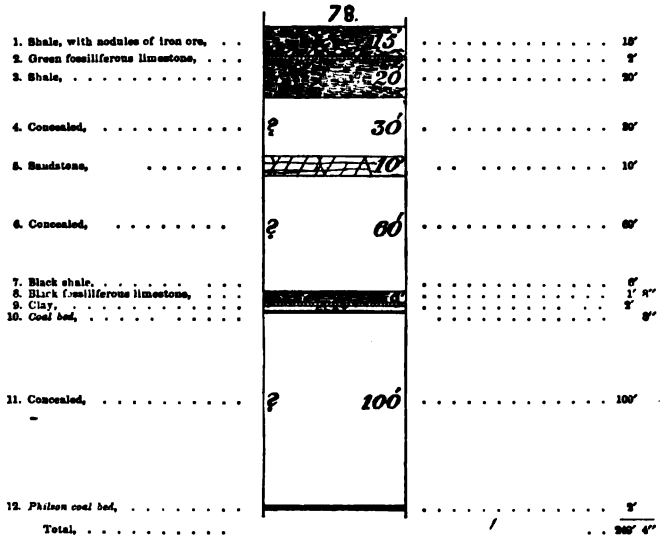
sufficiently well exposed in the bed of the run. It is a massive sandstone, gray, coarse-grained, quite hard and breaks into huge fragments, which sometimes choke the stream. The iron ore, No. 28, is the same with that so extensively benched near the pike for Washington furnace, but it is no longer exposed. Fragments of the ore still to be found on the dump show it to be a bluish carbonate. But with it there is associated a very inferior sandy ore.

The remainder of the section is very poorly shown along the run.

Zimmerman's Run. This little stream enters the Loyalhanna just below the mouth of Laurel run, about two miles east from Ligonier. Near its head the following section was obtained on the property of Mr. J. Menoher: (Fig. 78.)

78.


1. Shale, with nodules of iron ore, . . .
2. Green fossiliferous limestone, . . .
3. Shale, ...
4. Concealed, ... ? 30'
5. Sandstone, ... 10'
6. Concealed, ... ? 60'
7. Black shale, ...
8. Black fossiliferous limestone, . . .
9. Clay, ...
10. Coal bed, ...
11. Concealed, ... ? 100'
12. Philson coal bed, ...
Total, ...

The Green Fossiliferous limestone is exposed on Mr. Menoher's property near the head of the east fork of this run and on the Forbes road near the head of the other fork. The upper portion only is shown and is a green calcareous shale crowded with well preserved specimens of *Spirifer planoconvexus*.

The sandstone, No. 5, the same with No. 20 of the Lower Barrens section along the Loyalhanna, is a fine massive

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rock, well shown on Mr. Menoher's property along the east fork of the run. Near the head of the other fork it tends to be shaly, but at about a mile down the run it is quarried for use as curbstones in Ligonier and at that quarry it is a massive rock, soft, splitting easily and dressing admirably.

The Black Fossiliferous limestone is exposed on both forks and occurs in three layers, of which the top and bottom ones are iron ore while the middle one, little more than two inches thick, is a ferruginous limestone. The top layer is richly fossiliferous and contains vast numbers of crinoidal stems, which retain a grayish color, and contrast sharply with the dull tint of the rock. This material was digged as iron ore in the early days and was reduced at Washington furnace. It cannot fail to be very inferior and to contain much phosphorus. The shale associated with this limestone contains many fossils.

On the east fork of the run the *Philson coal bed* is 2 ft. thick and is rudely mined by Mr. Menoher. Half a mile below the junction of the forks it is exposed in a bluff and underlies 20 ft. of shale. Where the run crosses the pike, the coal is shown on both sides of the stream and seems to be little more than one foot thick.

Mill Creek. This large stream enters the Loyalhanna at barely half a mile below Ligonier. At its mouth the Morgantown sandstone is above the stream and the *Elk Lick coal bed* is reached in the bank of the Loyalhanna. No exposures occur in the immediate vicinity of the run for some distance as the "bottom" is very broad, but just east from it and only a little way north from the pike, a high knob catches the *Pittsburg coal bed*, having in all an area of four or five acres. The bed has very little cover and for the most part is worthless; but when the fields are ploughed one can see the black band of coal for a long distance. On the road leading north from Ligonier to Meyer's schoolhouse, the *coal bed*, No. 7, of the section opposite Ligonier is exposed before the summit of the hill is reached and on the opposite side the following section was obtained: (Fig. 79.)

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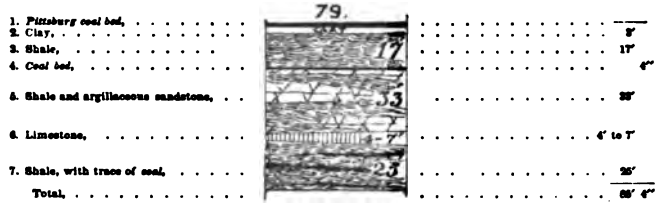
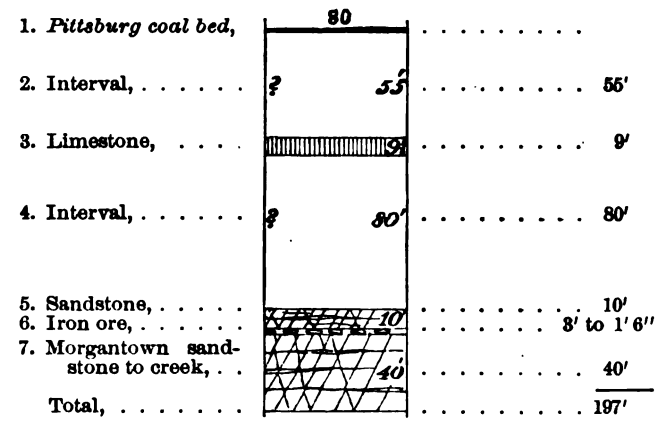


The limestone, No. 6, the same with that quarried on the Smith property opposite Ligonier, is quarried here by Mr. Seaton and is found on every property within this elevated area between the Loyalhanna and the Conemaugh. The lime obtained from it is excellent for all purposes and the bed is the main source of supply for a very extensive region.

Along the Johnstown pike the Morgantown sandstone is exposed to Oak Grove furnace, the direction from Ligonier almost coinciding with the strike. On Hannas run, entering Mill creek at the furnace, the following section was found: (Fig. 80.)



The limestone was seen on Mr. Clifford's property, but the exposure was imperfect and the thickness is given on information. The iron ore, which is that formerly used at the furnace, was benched extensively on land belonging to Mr. R. M. Graham, but it is no longer exposed. It rests almost directly on the Morgantown sandstone and is said to be from 18 inches to 3 feet thick. Much is claimed for it as a

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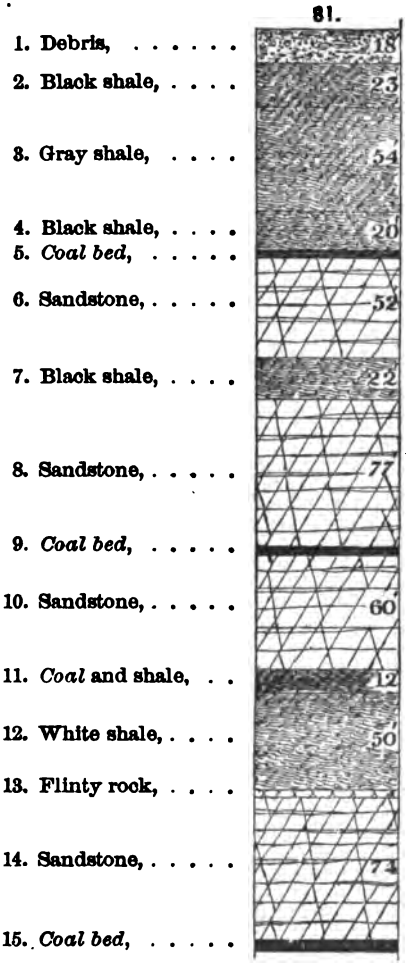
calcareous ore, so rich in lime that no additional flux is needed, but the appearance of the ore hardly suggests such a composition. This must have been thought valuable, as it was benched under 12 feet of cover. It was used at old Hermitage furnace fifty years ago.

Above Oak Grove Furnace the valley is broad and the hills show few exposures, except those of the Morgantown sandstone, which forms a cliff at Waterford, nearly two miles



1. Debris,	18′
2. Black shale,	23′
3. Gray shale,	54′
4. Black shale,	20′
5. *Coal bed*,	4′
6. Sandstone,	52′
7. Black shale,	22′
8. Sandstone,	77′
9. *Coal bed*,	4′
10. Sandstone,	60′
11. *Coal* and shale,	12′
12. White shale,	50′
13. Flinty rock,	4′
14. Sandstone,	74′
15. *Coal bed*,	6′
Total,	480′

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farther up. The stream rises almost as rapidly as the rocks and the dip is not very sharp. At Waterford a boring for oil was made some years ago, of which the following record was given me by Mr. R. M. Graham of Oak Grove. (Fig. 81.)

From Waterford to Murphy's mill, the rise of the creek-bed is nearly 90 feet. Just above the mill is a well, 16 feet deep, which stopped in a thick bed of carbonaceous shale. This is the No. 7 of the oil-boring, which shows a rise of 250 feet from Waterford to this point, and that shale is the one associated with the Black Fossiliferous limestone. That shale frequently contains a large amount of carbonaceous matter and often is mistaken for cannel coal, as it was at Murphy's mill. No. 9 of the section is the *Philson coal bed*, and No. 11 the *Upper Freeport*. It should be understood that no reliance can be placed upon measurements of coal beds, when made in the careless manner characteristic of the ordinary borer. No. 15 is the *Lower Kittanning*, the same with that mined by Mr. Hall on Laurel run. The coal bed, No. 5, occurs in an interval, which throughout this portion of the district is always concealed.

On the north fork of Mill creek a coal bed is exposed in the bluff at about a mile above Murphy's mill, and it is very probably the *Upper Freeport*. On the middle fork, which flows almost in the direction of dip, the Pottsville conglomerate is found at the same distance from the mill.

The carbonaceous shale found in the well at Murphy's mill is thought by some to be the *Upper Freeport coal bed*, the same with that mined by Mr. Armour and Dr. Burnett near Laughlinstown. This is altogether impossible, as appears from an examination of the country along the road leading from the mill to Laughlinstown. This road is constantly in the Lower Barrens for three miles, and at the first fork, one mile south from the mill and a few feet lower than the top of the well, there is a good exposure of rocks belonging to the lower portion of the Barrens. The rise of the rocks is in this direction, so that were the shale in the Murphy well the *Upper Freeport coal bed* or below that,

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the Pottsville conglomerate should be at the surface at the fork referred to.

Following this road, one finds at the schoolhouse, two miles from Laughlinstown, the blossom of the *Philson coal bed.* It underlies 15 feet of shale and the Mahoning sandstone is but a few feet below it. No further exposures occur for half a mile, but there, at 170 feet below the *Philson* blossom, the *Lower Kittanning coal* is reached on Mr. Robert Hall's property.

——— *Run.* The only other stream entering the Loyalhanna from the north is a run emptying about three miles west from Ligonier. It flows along the base of Chestnut ridge, all the way through the Lower Barrens. There are no connected exposures. Mr. Keffer has opened a small coal bed, probably the *Elk Lick*, which varies from 2 feet to 2 feet 6 inches and yields a fairly good coal.

For the most part the east slope of Chestnut ridge within this township is densely wooded. The ravines are usually shallow and the coating of debris is very thick. No exposures of any member of the Lower Productive Coal Series was found and even the Conglomerate and the Silicious limestone are very imperfectly shown. The rocks of the Lower Coals reach in many places to the top of the ridge and, except in the deepest ravines, rocks lower than the Pottsville conglomerate are rarely exposed.

South from the Bedford Pike.

Along the Loyalhanna within this township the road lies almost wholly within the Lower Barren Series, but for the most part the outcrop of the *Upper Freeport coal bed* lies only a little east from it.

Between the Pike and Furnace Run. The outcrop of the *Upper Freeport coal bed* lies at a little distance west from the road leading from Laughlinstown to California furnace, so that the road lies in the Lower Coals. At about midway between the two points, ore belonging to the horizon of the Upper Kittanning limestone has been digged, the limestone being absent, but at a short distance further south the limestone is present and it has been quarried. At

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Westmoreland furnace, the sandstone overlying the *Clarion coal bed* is reached and there a coal blossom rests on it.

Furnace Run. Above California furnace the Pottsville conglomerate comes down to the run, and the *Brookville coal bed* with the blue iron ore is shown above it. The face of the hill is gently sloping, the sandstone over the ore having been removed for some distance back from the run, so that the ore can easily be benched. The old benchings extend for nearly two miles along the run. The *Brookville coal bed* has been opened opposite the house formerly occupied by the superintendent of the furnace and shows: (Fig. 82.)

82.

1. Shale,		8′
2. Black shale,		8″
3. *Coal*,	1′ 2″	
4. Clay,	10″	
5. *Coal*,	1′ 8″	8′ 9″+
6. Clay,	8″	
7. *Coal*,	?	
Total,		12′ 5″

No. 7 is not exposed and its existence was ascertained by digging through the clay, No. 6, which is excessively hard. The coal seems to be of very fair quality, but owing to the presence of the slates it cannot be mined to profit. The sandstone belonging over the ore is shown in the face of the hill. The ore bed is no longer exposed, as the furnace was abandoned many years ago, but fragments lying about the surface show that it does not differ materially from the same deposit as exposed near old Washington furnace.

Near the old Westmoreland furnace, Mr. Laughery has an opening in the *Clarion coal bed*, which shows the coal from 4 to 5 feet thick. The sandstone overlies it as on Laurel run and the coal is of fair quality. Where the road crosses the run below the old furnace a deserted opening in the *Lower Kittanning coal bed* was seen, in which the coal is said to be somewhat more than 3 feet thick. Neither the

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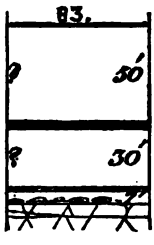
Upper Kittanning coal bed nor its limestone was seen, nor does the *Lower Freeport coal bed* show any blossom. The *Upper Freeport* comes down to the run nearly opposite the woolen factory.

Between Furnace run and Linn's run the outcrop of the *Upper Freeport* lies just back from the first ridge east from the creek.

Linn's Run. This enters the Loyalhanna at Mechanicsburg. There the Mahoning sandstone is exposed and the *Upper Freeport coal bed* is reached in the wells. The sandstone rises rapidly up the run, and the coal is exposed at a short distance below the grist-mill as well as in the bank opposite that mill. An opening at a little way further up shows the bed 2 feet 9 inches to 3 feet 1 inch thick. The *Philson coal bed* is exposed higher up in the hill and an old opening showed it to be 2 feet 10 inches thick. These beds run out in the hills at a little more than half a mile east from Mechanicsburg, and the coal from both is quite good.

The exposures are very poor for a mile above the mill, but on Mr. Jesse Rector's property, the following section was obtained: (Fig. 83.)



1. *Upper Kittann'g coal bed*,	?
2. Interval,	50'
3. *Lower Kittann'g coal bed*,	3' 4"
4. Interval,	30'
5. Carbonaceous shale,	1' 8"
6. Clay, with iron ore,	7'
7. Sandstone,	?
Total,	92'

No. 1 is caught at the summit of the hill, and its thickness cannot be made out. The Upper Kittanning limestone is wanting here, as well as on Mr. Bitner's property on the opposite side of the run, and the conditions are similar to those observed on the Hall farm, east from the Waterford road. For instead of the limestone there is a shale containing much nodular iron ore, which, however, is quite silicious. This shale is apparently continuous to the *Lower Kittanning coal*, and at some distance below Mr. Rector's house

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a deposit of bog iron ore derived from these shales extends along both sides of the run.

The *Lower Kittanning coal bed* is mined by Mr. Rector, at whose pit the bed is 3 feet 4 inches to 3 feet 6 inches thick, and similar in most respects to the openings seen on Laurel run. The upper portion is slaty on top for from 5 to 8 inches, but it improves downward to the parting, which consists of 4 inches of bony coal. The lower portion is soft and clean, so that it is an excellent smithing coal. The same coal bed is opened by Mr. Enos, further up the run, but the cover is so thin that the coal is practically worthless. Below the coal is plastic fireclay 7 feet, resting on 3 feet of excessively hard sandstone or grit, which contains a great deal of carbonaceous matter, and is almost flint-like in its toughness. Below this, to No. 5, the interval is imperfectly exposed, but it seems to be filled with shale.

The carbonaceous shale, No. 5, is the same with that seen on Furnace run, near Westmoreland furnace. It is quite well marked on this run, being exposed for some distance both above and below Mr. Rector's house. The interval between the *Lower Kittanning coal bed* and the sandstone, No. 7, is much greater here than is given in the Laurel run section, and there is some probability that the interval there given is too small, as no direct measurement could be obtained, and the interval was estimated.

The sandstone, No. 7, that which overlies the *Clarion coal bed*, is well shown in the run above Mr. Rector's house, but no determination of its thickness could be made, as the rock is not exposed in the banks of the stream. It is massive, and shows no lines of bedding.

Near the township line the following section is exposed in a little glen. (Fig. 84.)

The coal bed No. 1 is no longer exposed, except by its blossom. An opening was made in it some years ago, when it was found to be 1 foot 6 inches thick. The clays, No. 4, contain about 4 feet of good plastic clay filled with stems or rootlets, and in general characters the whole mass closely resembles the clay found at Bolivar under the *Clarion coal bed*. The iron ore, No. 7, is now concealed by a heavy mass

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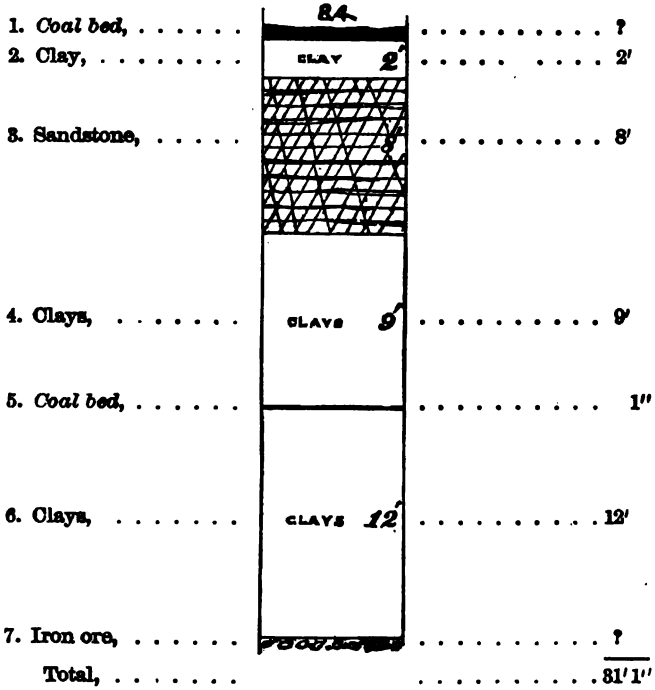

of debris, but it is said to be one foot thick. Fragments lying on the surface show that it is much like the ore digged for Washington furnace on the pike. A thick sandstone seen in the hill near by is very similar to that overlying the *Clarion coal bed.* Owing to the dense undergrowth the relations of the coal bed could not be traced out, but the probabilities are that the bed is the *Clarion.* Above this the exposures are very poor, until at the township line the Pottsville conglomerate appears in the run and forms an abrupt wall on each side of the stream.

Between Linn's run and the township line the road following the Loyalhanna passes on the Mahoning sandstone.

Between the Loyalhanna and Four-mile run. Along the road leading from Ligonier to Stahlstown there are no exposures. The only features of interest are some terraces which have been referred to in the chapter on Surface geology.

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On the road leading from Ligonier to Brant's knob, the *coal bed* No. 7 of the Ligonier section, is exposed at a mile and three fourths from Ligonier, and at 45 feet higher is a coal bed, 8 inches thick, with limestone clay underneath it. Above the latter coal is shale for 30 feet, which brings one to the crest of the hill at 250 feet above the Loyalhanna bridge at Ligonier.

Near Mr. Brant's residence, three miles from Ligonier, there are two very small patches of the *Pittsburg coal bed*, each containing barely two acres. The one on the south side of the road is now owned by Mr. Weller, who works the bed, but most of the coal has been removed. The other on the opposite side of the road is owned by Mr. Brant, but the coal is mined by Mr. Dickie. Both knobs fail to catch the little coal bed found further north. The limestone at 60 feet below the *Pittsburg coal* is quarried on both hills, and varies from 4 to 5 feet. The Morgantown sandstone is well shown in the road below Mr. Weller's residence, and in a hollow further down, the *Elk Lick coal bed* has been found 4 feet thick, but the blossom only is now exposed. These two hills are the only ones south from the immediate vicinity of Loyalhanna creek which catch the *Pittsburg coal bed*, and it is said that no others catch the thick limestone below that coal bed; but it is altogether probable that some of the high hills in the southern portion of the township have the limestone near their summits, though in every case the area must be very small.

Along the run entering the Loyalhanna at Boucher's mills, two miles below Ligonier, there are no connected exposures. The Morgantown sandstone is seen near the hill top, at about a mile and a half from the creek, and in the bank of the run, half a mile from the creek, the shales associated with the Black Fossiliferous limestone are exposed.

Four-mile run. This enters the Loyalhanna from the south at somewhat more than three miles west from Ligonier, and within this township flows almost wholly through the Lower Barren Series, as the Lower Productive Coals pass under the surface far east from the line of this stream. Ex-

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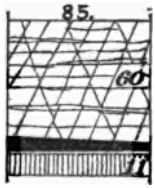
cept near the Loyalhanna, the Lower Coals reach the crest of Chestnut ridge, and the shallow hollows through which the streams flow are seldom deep enough to expose anything below the Pottsville conglomerate.

On the road leading from Nicely's mill to Youngstown the blossom of the *Philson coal bed* is exposed near the saw-mill, half a mile from Four-mile run, and at a few feet above it there is a limestone which was not seen at any other locality. Half a mile above the saw-mill, the *Upper Freeport coal bed* has been opened on Mr. J. Nicely's property, where the following exposure was seen: (Fig. 85.)



1. Mahoning sandstone, seen, ... 60′
2. Upper Freeport coal bed, ... 7″ to 9″
3. Clay, ... 1″
4. Freeport limestone, ... 11′
Total, ... 60′

The sandstone is imperfectly shown and for the most part is quite flaggy. The coal bed varies as given in the section. In a new opening the structure is:

Coal,	1′ 9″
Clay,	5″
Coal,	2″
Coal and clay,	11″
Coal,	1 5″
Total,	4′ 8″

The upper clay is from 2 to 5 inches and in many parts of the old pit the lower clay wholly disappears, its place being occupied by clean coal. The coal from this bed is a good fuel though it contains a good deal of sulphur.

The Freeport limestone is quarried and burned into lime which is said to be very good for agricultural purposes. The rock is dull lead-colored in the upper portion and a blue slaty layer rests on it. The lower portion is quite clean.

Above this, along the run there are no exposures until near the crest of the mountain, where Mr. Ross mines a coal bed, which is probably the *Clarion* and shows a thickness of 5 feet.

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Area of the Upper Productive Coal Series.

In Ligonier township this lies north from Ligonier on the high dividing ridge separating the waters of the Loyalhanna from those of the Conemaugh, and is wholly on the western side of the trough.

Northward from the borough of Ligonier the *Pittsburg coal bed* is first mined on the property of Mr. T. Seaton, at whose bank the exposure is as follows: (Fig. 86.)

1. Brown shale, ...	. . . . .	8′
2. Black shale, ...	. . . . . 1′	
3. *Coal*, ...	. . . . . 4′ 2″	8′ 5″
4. *Coal* and partings, .	. . . . . 2″	
5. *Coal*, ...	. . . . . 3′ 1″	
Total, ...		16″ 5″

The roof division is clearly represented by the black shale No. 2, which in this valley usually contains thin layers of coal. In this pit horsebacks are not rare but they seldom cut away more than one foot of coal, and the largest yet found extends for only ten feet along the entry. Clay veins are unknown. The whole bed yields good coal. Below the middle in No. 3 there is a persistent parting, from which to No. 4 the coal is prismatic and so tender that the columns in many places can be detached by the fingers. Very little pyrites occurs and for the most part it is confined to the persistent parting above No. 5. The parting above No. 4 is not persistent.

At a short distance north from this opening one of the main areas is reached. Though excessively irregular in outline, it is of no small importance, as the streams so cut it that the whole of the coal is accessible with natural drainage. Near the old McDowell property, now belong-

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ing to Col. J. McFarland, it is almost divided, one prong extending south of west nearly to the Seaton bank, the other reaching in a southeastward direction nearly to Mill creek, its northeast boundary being Hanna's run. Openings in the *Pittsburg* were seen here belonging to Mr. Knox, Mr. Meyers, Mr. Breniser, Mr. Peoples, Mr. Tash and Col. McFarland.

At Mr. Knox's bank, the next north from that belonging to Mr. Seaton, the exposure is: (Fig. 87.)

87.

1. Shale,	10′	
2. *Coal*,	2″	8′
3. Slaty *coal*,	5″	
4. *Coal*,	2′	
5. *Coal*,	2′ 8″	
6. *Coal*,	2′ 8″	
Total,		18′

Between 4 and 5 and 5 and 6 there is a thin parting of one half inch. The Nos. 1 and 2 are very like the roof coal seen in the Blairsville trough, and the lower portion of the overlying shale is dark. The bed is not troubled by clay-veins or horsebacks and the coal does not differ from that obtained at Mr. Seaton's bank.

On the road leading from Meyers schoolhouse to Mill creek, the coal is mined by Mr. Breniser who has two pits. The structure of the bed here is: (Fig. 88.)

88.

1. *Coal*,	2″	9′ 2″
2. Bony *coal*,	6″	
3. *Coal*,	1′ 9″	
4. Parting,	½″	
5. *Coal*,	2′ 7″	
6. Clay,	1″	
7. *Coal*,	2′ 8″	

The bed is perhaps 4 inches thicker, as the bottom is not reached in the entry. Nos. 1 and 2 represent the roof divi-

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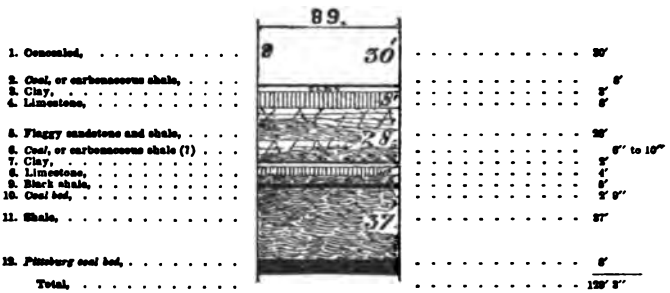
sion. No. 3 is comparatively hard and contains much semi-cannel. The middle bench or No. 5 is prismatic and readily splits across the bedding. The partings are very hard; ten feet of the overlying shale are exposed at these pits and the base for one foot contains much carbonaceous matter.

At the schoolhouse the following section was obtained, beginning at the hill-top and descending to the *Pittsburg coal bed:* (Fig. 89.)


89.
30'
57
35
57
1. Concealed, ... 30'
2. Coal, or carbonaceous shale, ... 6"
3. Clay, ... 5'
4. Limestone, ... 6'
5. Flaggy sandstone and shale, ... 25'
6. Coal, or carbonaceous shale (?) . . . 6" to 10"
7. Clay, ... 5'
8. Limestone, ... 4'
9. Black shale, ... 6'
10. Coal bed, ... 5' 6"
11. Shale, ... 57'
12. Pittsburg coal bed, ... 6'
Total, ... 129' 6"

The limestone, No. 4, was seen only on this hill where it is quarried by Mr. Breniser, and yields a lime good enough for agricultural purposes. It is certainly present on Mr. Tash's property and on that of Mr. Breniser toward Mill Creek, though it is not exposed on either of those farms. No. 2 may be either coal or carbonaceous shale. It is not exposed and the bed is referred to only because its existence was positively asserted by a quarryman. The limestone, No. 8, is quarried by Mr. Meyers, Mr. Breniser, Mr. Tash and Col. McFarland. It is well exposed in the road on all sides of the Meyers schoolhouse. Some of the layers are very good while others are decidedly inferior. The better layers yield a strong but dark lime. Both of the limestones are ferruginous, rusty on the weathered surface, but blue to dark brown on the fresh surface.

No. 6 is very imperfectly exposed at the roadside just beyond the schoolhouse and its thickness is given according to information received from one who has quarried the limestone. There are many exposures of the limestone in the roads but at no one of them except that near the school-

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house is there any evidence that either coal or carbonaceous shale is present above it. At all of them except that near the schoolhouse the coal is positively absent and I am quite inclined to believe the statement that the coal exists to be wholly inaccurate. In the report of the First Geological Survey of Pennsylvania a thick coal bed is mentioned as occurring at this horizon, but that statement was clearly the result of mistaking the coal under the limestone for one over it. No thick bed exists here, and at every locality where the exposure is complete there is neither coal nor carbonaceous shale present.

The *coal bed* No. 10 is well shown at the roadside by the Meyers schoolhouse where the structure is:

Coal,	1′
Clay,	1″
Coal,	1′ 8″
Total,	2′ 9″

This bed is not mined anywhere in this neighborhood and the quality of the coal could not be ascertained.

Northeast from Hannas run a small detached area of the *Pittsburg coal bed* was seen on Mr. Robb's property and a still smaller fragment occurs on Mr. Pollock's farm. The latter is the most eastern exposure of the bed. From both of these the coal has been almost wholly removed and neither shows any exposures above the *Pittsburg*.

A still larger area than any yet referred to lies a little north, being separated from the others by Hannas run. It occupies the crest of the dividing ridge and embraces portions of both Ligonier and Fairfield townships. The details respecting this area will be found under the description of Fairfield township.

11. Fairfield Township of Westmoreland County.

This township adjoins Ligonier at the north and has the Conemaugh river for its northern boundary. The exposed section extends from nearly 200 feet above the *Pittsburg coal bed* to the Devonian rocks, the latter being exposed in the Conemaugh gap through Chestnut ridge, as well as in the deep gorge of Tub-mill run on the side of Laurel ridge.

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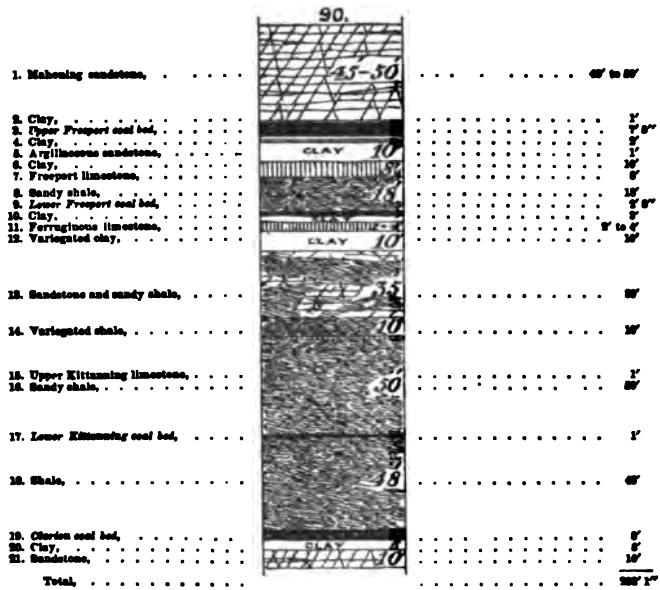
Along the Pennsylvania Railroad. On the Pennsylvania Railroad a long side-cutting begins almost immediately east from Lockport and continues eastward beyond the township line into St. Clair. In this the section given in Fig. 90 was obtained within this township:



Below No. 16 there are no exposures on the Westmoreland side of the Conemaugh and the rest of the section was obtained on the opposite side by Mr. W. G. Platt, who kindly furnished me with the measurements.

The Mahoning sandstone is a massive rock containing few pockets of shale or shaly sandstone and it seems to be fine-grained throughout, no conglomerate layers having been observed. Some portions show numerous impressions of plant stems but casts appear to be wholly wanting. This rock is finely shown at the township line, little more than a mile east from Lockport.

Just west from the township line the *Upper Freeport coal bed* is well exposed and shows the following structure: (Fig. 91.)

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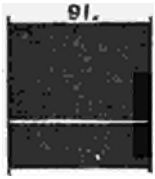
91.

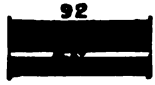


Coal,	5′
Clay,	2″
Coal,	2′ 3″
Total,	7′ 5″

The upper division is unusually thick here and appears to contain no parting, while the main parting and the lower division are unusually thin. The Freeport limestone is quite irregular, sometimes represented only by nodules, while again it is a compact bed in three layers showing the full thickness given in the section. For the most part the rock is ferruginous and contains much clay, being what is usually termed "bastard" limestone. Nearly midway in the sandy shale below it there seems to be a thin coal bed. The Bolivar fireclay is poorly represented and the clays between the coal and the limestone are of indifferent quality.

Like the *Upper Freeport* the *Lower Freeport coal bed* is double, showing: (Fig. 92.)

92



Coal,	1′ 8″
Clay,	3″
Coal,	9″
Total,	2′ 8″

It is seriously distorted here, being thrown into a series of short waves, and during the formation of the overlying shale it was badly eroded, so that the upper bench varies from one inch to twenty inches, while at one place in the cut the whole bed has been removed. The coal is but moderately good and shows a good deal of pyrites. The limestone below this bed is exceedingly ferruginous and at some portions of the exposure is a calcareous ore. It is by no means regular and is represented occasionally only by nodules.

The *Upper Kittanning coal bed* should appear just above the *Upper Kittanning* limestone, No. 15, but on this side of the river it is wanting. Mr. W. G. Platt has found it 1 ft. 10 in. thick on the opposite side of the river, where it is 6 feet above the limestone. The latter rock is dark gray

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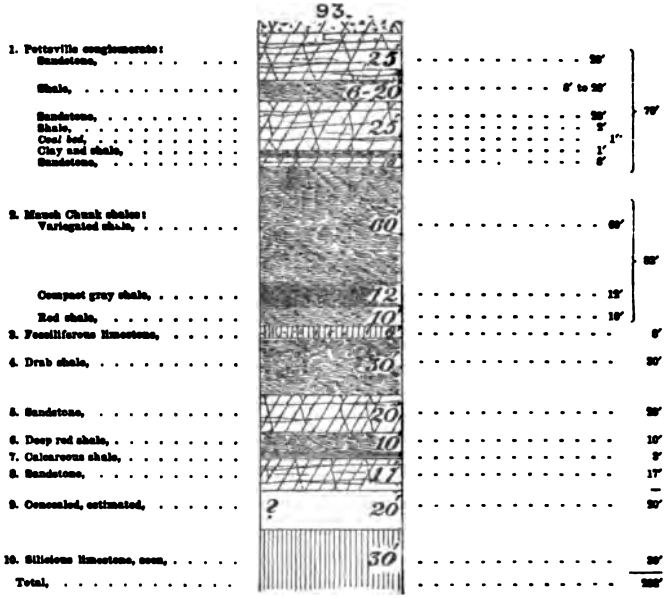
inside but weathers to a dirty white. The sandy shale, No. 16, becomes compact toward the base near Lockport.

The remainder of the section is concealed on the south side of the Conemaugh river.

In the gap of the Conemaugh immediately west from Bolivar the following section of the lower rocks was seen: (Fig. 93.)

93.



The upper division of the Pottsville conglomerate is compact, cross-bedded and for the most part quite fine-grained. At its base is a non-persistent layer of by no means coarse conglomerate. The shale between the two sandstones is irregular in thickness and the upper sandstone thickens or thins at its expense. The lower sandstone contains some thin layers of lead colored shale, one of which carries some carbonaceous matter. The lower portions of the mass, as given in the section, are sufficiently distinct in the cut, but respecting their persistence nothing can be ascertained, as their place is concealed on the hill-side as well as along the old Pennsylvania canal between the railroad and the river.

Of the Mauch Chunk shales the top bed is almost wholly

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argillaceous, but it contains a few sandy layers. No iron ore is present here, though the quantity disseminated throughout the mass is very great. The upper third shows no bedding and in the remaining portion the bedding is very indistinct. The middle shale is without bedding, is somewhat sandy and micaceous, while toward the base it becomes decidedly calcareous.

The Fossiliferous limestone is very impure, but it contains some layers, which would slake if carefully burned. When freshly exposed it is very hard, but for the most part it soon breaks down under the influence of the weather. Fossils are numerous in several of the layers, and the specimens are well preserved. Under this limestone is a mass of red shale somewhat calcareous, with which the exposures along the track cease, and the rest of the section was obtained on the old Pennsylvania canal, between the railroad and the river. The Fossiliferous limestone is well shown in the railroad cut east from the first house on the tow-path, about one mile from Bolivar.

The red shale, No. 6, is fine in grain, and no doubt it would answer very well as a mineral paint. The sandstone, No. 8, is said to make good grindstones, and some layers of No. 5 are said to be fine enough for hones. These layers, however, must be very local, for they are wanting at every locality where the bed is exposed.

The Silicious limestone is exposed at the first house on the tow-path. It seems to have been quarried to some extent, but for what purpose could not be ascertained. It shows the usual characters in color and structure. Fragments of the curiously conglomerate sandstone overlying this rock were seen here, but the bed itself is concealed.

No lower rocks are exposed along the railroad for nearly a mile. Fragmentary outcroppings of the Pocono sandstone appear in the hill side, and are sufficient to show that the rock is the same here as on the other side of the axis.

Immediately under the arch of the fold the Devonian rocks are shown to the thickness of nearly 300 feet, with fully 150 feet below concealed. As at all other exposures of this series there is about midway a conglomerate, while

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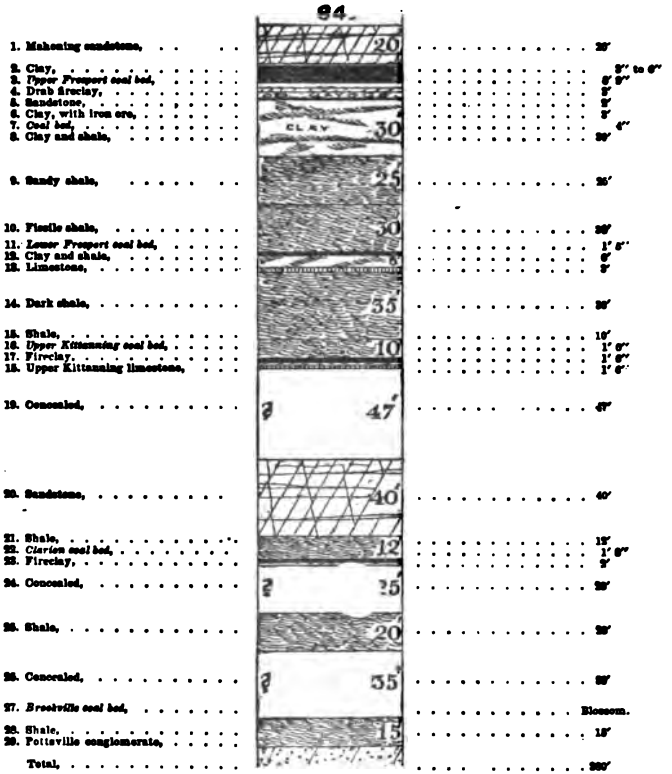
the rest of the mass consists of shales or shaly micaceous sandstones varying in color from brown to red and olive. In the more compact layers the Chemung fossils are abundant.

On the west side of the axis the Pocono sandstone is finely exposed, and is an almost unbroken sandstone, mostly fine-grained and excessively hard. Further west the Silicious limestone of the Umbral is fully exposed, but between that and the Pottsville conglomerate the exposures are very imperfect. The conglomerate is utterly insignificant, and is merely an irregular sandstone, which looks as though it were only a nest of rock in the shales. Below it one of the *Sharon coals* is shown by its blossom.

Along Tub-mill Run. This stream rises on the west slope of Laurel ridge, and flowing across the valley enters the


94
1. Mahoning sandstone, 20'
2. Clay, 0" to 6"
3. Upper Freeport coal bed, 6" 6"
4. Drab fireclay, 2'
5. Sandstone, 5'
6. Clay, with iron ore, 5'
7. Coal bed, 4"
8. Clay and shale, CLAY 30' 30'
9. Sandy shale, 25' 25'
10. Flaggy shale, 30' 30'
11. Lower Freeport coal bed, 1' 6"
12. Clay and shale, 6"
13. Limestone, 2'
14. Dark shale, 35' 35'
15. Shale, 10'
16. Upper Kittanning coal bed, 1' 6"
17. Fireclay, 1' 6"
18. Upper Kittanning limestone, 1' 6"
19. Concealed, 47' 47'
20. Sandstone, 40' 40'
21. Shale, 12'
22. Clarion coal bed, 1' 6"
23. Fireclay, 2'
24. Concealed, 25' 25'
25. Shale, 20' 20'
26. Concealed, 35' 35'
27. Brookville coal bed, Blossom.
28. Shale, 15'
29. Pottsville conglomerate, 15'
Total, 300'

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Conemaugh at the east base of Chestnut ridge immediately west from Bolivar. In the vicinity of Bolivar the section represented by Fig. 94 was obtained:

The *Upper Freeport coal bed* is well exposed along the run up to within a mile of Covodeville. At about a mile from the river a long exposure on the south side of the stream shows it separated from the Mahoning sandstone by from 3 to 6 inches of clay. The bed is in two distinct divisions, the intimate structure being as follows:

Coal,		10″ to 11″
Bone *coal*,		1″ to 8″
Coal,	2′	4″
Main parting,		9″
Coal,	4′	6″
Total,	8′	9″

The upper division is much thinner than at the exposure on the railroad near Lockport, while the thickness of the lower division is much greater. The top bench of the roof division is very poor, sometimes becoming a wretched clayey shale, which is left in the pit. The bottom bench of the same division is broken by thin partings barely two thirds of an inch apart, but the coal is brilliant, and no doubt it is quite clean. The main parting is compact, more or less carbonaceous throughout, and contains streaks of extremely brilliant coal. The lower division is less broken by partings, but there are enough of them to render lump coal almost impossible. The luster of coal from this division resembles that of the *Pittsburg coal* in the Blairsville basin, and contrasts strongly with that of the coal from the upper division. Clay-veins appear to be absent, but the lower division contains many pockets of sooty material. On Mr. Sowder's property, further up the run, the upper division of the bed is worked, and is 3 feet 7 inches thick.

The fireclay immediately below the coal is occasionally digged, but it seems to be too irregular to be mined with profit. The sandstone, No. 5, which seems to occupy the place of the Freeport limestone, is gray, hard, and somewhat micaceous. No. 6 is sometimes digged, but the nodules of iron ore are so numerous that it can be used only with

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difficulty. The ore is nodular, and thoroughly oxidized for some distance, a shell breaking off and leaving a hard core of gray carbonate. It is evidently a rich ore, but the distribution is such that mining would be unprofitable. The little *coal bed, No. 7*, is persistent for some distance, having been observed on both sides of Tub-mill.

No. 8 contains the non-plastic Bolivar fireclay, which is of somewhat irregular occurrence, as it varies from 3 to 12 feet in thickness and in some cases is wholly wanting. Its character changes abruptly and at times the clay is replaced by a hard sandy shale. On the north side of the creek there are many excavations from which this clay was obtained, but the supply conveniently at hand seems to have been exhausted, for the material now used at Bolivar is brought from the north side of the Conemaugh river. But a large area along White's run and the base of Chestnut ridge remains untouched. This clay contains much nodular iron ore, like that of No. 6.

At one time the firebrick made at Bolivar had a high reputation and were thought second only to those from Mount Savage, but through carelessness in selecting the clay the bricks became poor and the brand is not rated so highly. The firm now engaged in the manufacture uses all necessary care in the selection and the bricks made are equal to those which gave the clay its reputation. The chief article of manufacture here is gas retorts, in which the mixture employed is:

Non-plastic clay, three sixths,
Plastic clay, one sixth,
Sandstone, two sixths.

These retorts find a ready market.

Nos. 9, 10 and 11 are well exposed near the old brickworks on the north side of the run. No. 10 is for the most part quite dark and contains a good deal of low grade carbonate ore. At ten feet from the base is a fairly persistent layer of that ore which was traced from where it rises above the stream to the final outcrop on the hillside near Bolivar. The shale has much vegetable matter, but the impressions

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of plants are rarely distinct. A few leaves of *Lepidodendron* and *Neuropteris* were recognized.

The *Lower Freeport coal bed*, which is known locally as the "blacksmith vein," rises from the creek near the old brick-works and crops out on the hill beyond the schoolhouse. Its blossom was seen on Mr. Lear's property on the opposite side of the stream near the top of the hill. At an opening alongside of the run near the bend, there is no visible parting in the bed, but the coal readily separates near the middle. This coal is said to be excellent for smiths' use. The interval between this and the *Upper Freeport coal bed* is very much greater than in the railroad section. The limestone, No. 13, is exposed for nearly three hundred feet along the bluff, but is inaccessible and its character could not be ascertained. It is evidently compact, but is ferruginous and the weathered surface is yellow. The shales, No. 14, are dark, mostly fissile, show occasional impressions of plants and contain much nodular iron ore. This ore occurs in nests, which are rudely triangular and are arranged with the longer diameter vertical to the plane of bedding. They are from one to four feet long and from two to ten inches wide. A very persistent layer was seen at fifteen feet below the limestone. The ore is inferior to that observed below the *Upper Freeport coal bed.*

At one time the *Upper Kittanning coal bed* was digged out of the run at about one third of a mile above Bolivar, where it showed the thickness given in the section and yielded very good coal. It was opened also by Mr. Lear on the south side of the stream, where it was found 18 inches thick, but the excavation was not carried far enough to reach solid coal. Below it at this place is fireclay resting on an impure limestone. On the railroad, about one fourth of a mile east from Bolivar, evidently the same bed is exposed above the track at the old brick-works. There it is 1 ft. 7 in. thick and has a soft fireclay 2 ft. thick immediately below it. This coal bed goes under the Conemaugh near the telegraph station above Bolivar.

Under this coal bed near Bolivar there is a concealed interval of 47 feet. On the railroad at Bolivar station a thin

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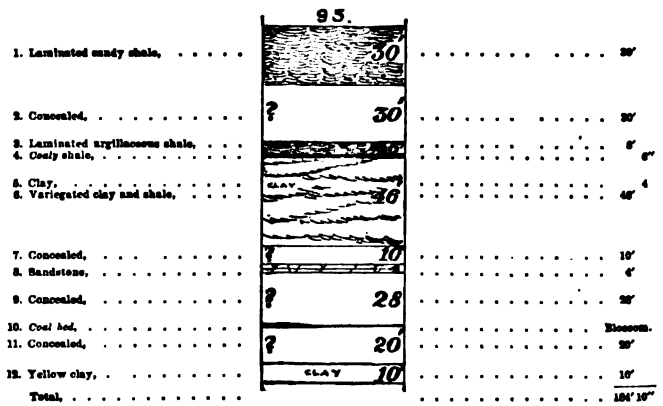
coal bed was found which seems to be about six feet above the sandstone, No. 20, and probably represents the *Lower Kittanning coal bed.* Near the opening in the *Upper Kittanning*, further along the railroad, 20 ft. of shale are seen below that bed, but at all other localities in this vicinity the whole interval is concealed.

A synclinal evidently crosses the railroad just east from Bolivar for at Lockport, which is but little north of east from Bolivar, the *Clarion coal bed* is 15 feet above the stream, whereas it goes under the river at a very short distance east from Bolivar. At Lockport a gentle anticlinal crosses the river.

The sandstone, No. 20, is well exposed as a cliff along Tub-mill up to half a mile from the river, where it passes under the stream. Its upper layers are white, very pure and are used at the Bolivar brick-works in the manufacture of gas-retorts.

The *Clarion coal bed* is known as the "soft-clay" vein in distinction from the *Upper Freeport* which is called the hard-clay vein. The coal is of fairly good quality and is used for fuel at the mill. The underlying clay is lead-colored, contains many rootlets and is mixed with the hard clay at the brick-works. The *Brookville coal bed* is at the river level near Bolivar and its blossom is exposed in a railroad cut west from the village.

Following up Tub-mill above where the *Upper Freeport*


93.
1. Laminated sandy shale, ... 30' . . . . . 30'
2. Concealed, ... ? 30' . . . . . 30'
3. Laminated argillaceous shale, ... 6'
4. Coaly shale, ... 6"
5. Clay, ... CLAY 4
6. Variegated clay and shale, ... 36' . . . . . 40'
7. Concealed, ... ? 10' . . . . . 10'
8. Sandstone, ... 4'
9. Concealed, ... ? 28' . . . . . 28'
10. Coal bed, ... Blossom.
11. Concealed, ... ? 20' . . . . . 20'
12. Yellow clay, ... CLAY 10' . . . . . 10'
Total, ... 104' 10"

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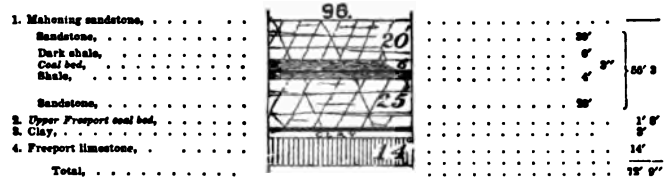
coal bed goes under, one finds no good exposures, though the Mahoning sandstone remains in sight almost to Covodeville. Between that place and West Fairfield everything is concealed, but on the hill leading from the latter village to the run, on the way to New Florence, the following imperfect section belonging to near the base of the Lower Barrens was seen. (Fig. 95.)

Returning to the main stream one finds Mr. T. Neil's quarry in the Freeport limestone at a short distance above Ross furnace where the section is: (Fig. 96.)



The *Upper Freeport coal bed* is not fully exposed and the measurement was made on a slip. Some shale may intervene between the coal and the Mahoning sandstone. The limestone is dull bluish gray, clearly quite argillaceous, but when carefully burned it yields a lime which answers very well for agricultural purposes.

The black shale in the Mahoning sandstone is said to be quite good as an iron ore and it is reported to have been used as such at the Laurel Hill furnace. But if it were employed to any extent, its use shows that iron ore is not a plentiful article in the vicinity, for the material is certainly very lean. Just east from this exposure is a coal bed on Mr. Trimble's property, which is said to be four feet thick and to yield excellent coal. This is probably the *Philson coal bed*, and, judging from the dip, it cannot be more than 15 feet above the top of the section.

Further up the run the exposures are very unsatisfactory. The hills are covered by a dense growth of laurel, which is almost impenetrable and conceals everything. Fragmentary exhibitions of the Mountain and Silicious limestones were found, but they were of no service in determining the relations of those rocks.

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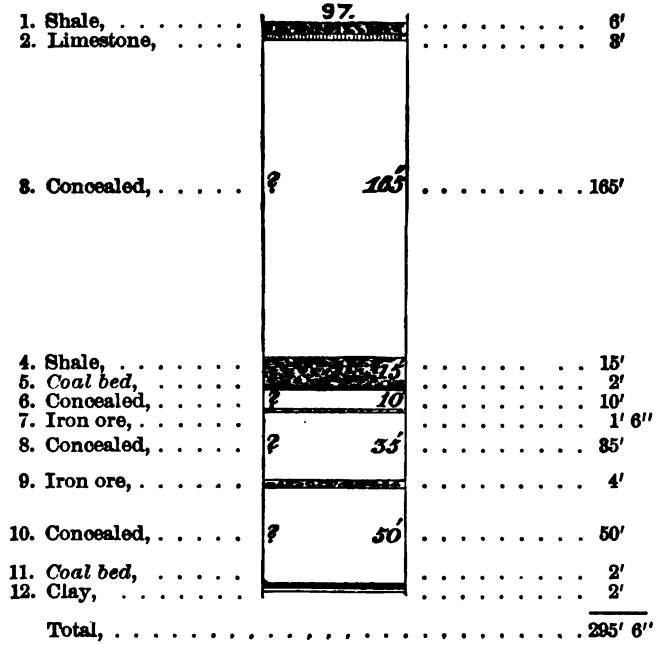
On Hendrick's run, the southern fork of Tub-mill, the exposures are poor and no direct measurements of intervals could be obtained. The following section made on Mr. J. McElroy's property is the least bad of those made along this stream: (Fig. 97.)


97.
1. Shale, ... 6′
2. Limestone, ... 8′
3. Concealed, ... ? 165 . . . . . 165′
4. Shale, ... 15 . . . . . 15′
5. Coal bed, ... 2′
6. Concealed, ... ? 10 . . . . . 10′
7. Iron ore, ... 1′ 6″
8. Concealed, ... ? 35 . . . . . 35′
9. Iron ore, ... 4′
10. Concealed, ... ? 50 . . . . . 50′
11. Coal bed, ... 2′
12. Clay, ... 2′
Total, ... 295′ 6″

The limestone, No. 2, is cream-colored, very clean and is burned by Mr. McElroy, who obtains a good lime from it. The bed is persistent in the hill-tops here. The intervals, Nos. 6 and 10, are certainly much too small, and the measurements given show only the barometric difference between the beds, it being impossible without careful instrumental measurement to do anything more. The iron ore, No. 7, is sandy and very inferior, but No. 9 is better. The latter is very near the place of the Black Fossiliferous limestone and in many respects closely resembles that stratum as seen on Zimmerman's run in Ligonier township of this county. It is very persistent and before Laurel Hill furnace went out of blast much of it was mined for reduction at that furnace. The coal bed, No. 11, is most probably the *Philson*, and it

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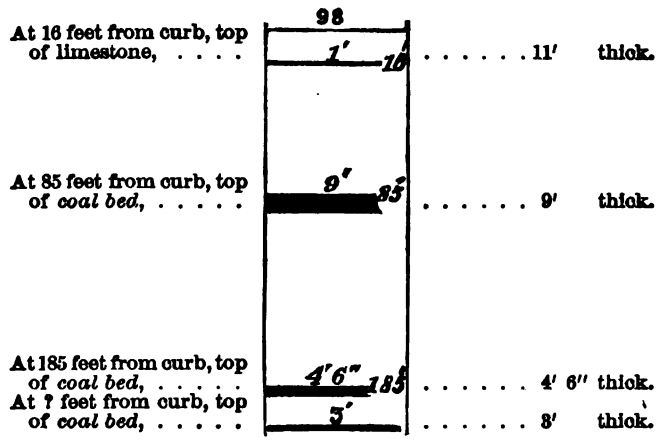
has been mined by stripping in the "bottom" at a little way below Mr. McElroy's house.

Some years ago a boring was made for oil at a few rods south from Mr. McElroy's house and directly alongside of the run. The Mahoning sandstone is exposed in the road near the well and the blossom of the *Upper Freeport coal bed* is shown in the hillside at a short distance southeast from the boring. No record exists, but the following details were given by Mr. McElroy: (Fig. 98.)


98
At 16 feet from curb, top of limestone, ...
1'
16'
. . . . . 11' thick.
At 85 feet from curb, top of *coal bed*, ...
9"
85'
. . . . . 9' thick.
At 185 feet from curb, top of *coal bed*, ...
4'6"
185'
. . . . . 4' 6" thick.
At ? feet from curb, top of *coal bed*, ...
5'
. . . . . 8' thick.

The limestone is clearly the Freeport. The lower portion, as shown by the fragments still lying round on the surface, is a very clean rock. The relations of the other beds are not distinct and there are no exposures along the stream to aid in making any determinations.

At 300 feet from the surface a powerful stream of water was struck, which still flows strongly from a four-inch hole. This water is chalybeate and a deposit of bog-iron ore is rapidly forming in the field through which the stream passes. Rude arrangements for bathing have been made, and the water is reputed to have extraordinary curative powers.

At a little distance further up the run is an extensive deposit of bog-iron ore on property belonging to Mr. Cooper and Mr. Louther. It covers an area of probably four or five acres. The deposit was formed by water from a spring

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on the northern side, but this was tapped by Mr. M'Elroy's boring and the bog is now dry.

At barely a mile further up the run are two coal pits belonging to John and Samuel Louther. They were not in shape to admit of measurement, but, in both, the coal is said to be about 5 feet thick. Everything in the vicinity is hopelessly concealed and the relations of the bed could not be determined. A similar bed was seen on the ridge between this stream and Tub-mill and its relations are equally uncertain. The ore-bed from which the stream in the oil-boring obtains its iron is exposed on the ridge about a mile east from the derrick. The ore was obtained here by stripping and was used at Ross furnace. No exposure of the bed could be found, which would give the thickness; but the quantity must be enormous as the main supply of the furnace for many years was obtained from this locality, yet the strippings cover only a few acres.

Along the face of Chestnut ridge the exposures are very incomplete. No openings in the *Upper Freeport coal bed* were found, though in the vicinity of White's run the blossom of that bed was occasionally seen. At a little distance south from the Conemaugh river the Pottsville conglomerate crosses the crest of the mountain and the lower rocks are reached only in the deeper ravines. The Mountain limestone is imperfectly exposed at the head of Snyder's run near the southern boundary of the township, but nothing could be learned from the exposure respecting its thickness.

The Upper Coal Area in Fairfield Township. In the south central portion of the township is a large area of the Upper Productive Coal Series which stretches over into Ligonier township. The western extremity is at Mr. Blair's on the ridge road leading from Ligonier to West Fairfield and the eastern is at the Presbyterian church on the pike between those places. Within this area openings were seen belonging to Mr. Blair, Mr. Hauger, Dr. Hartman, Mr. Lytle, Mr. Kountz, Mr. McKelvy and others. A small outlying area lies northwest from it on which are openings

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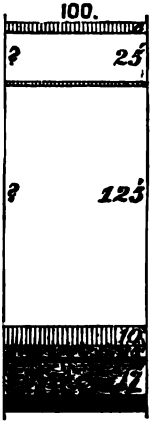
belonging to Mr. Kennedy and Mr. Ambrose. At Dr. Hartman's pit the section of the bed is: (Fig. 99.)

99.

1. Sandy shale, ...		7′
2. *Coal*, ...	4′ 4″	
3. *Coal* and partings, .	2½″	8′ 2½″
4. *Coal*, ...	3′ 8″	
Total, ...		15′ 2½″

In No. 2 is included the black shale, which is about 8 inches thick. Midway, or rather a little below midway in the upper bench is a parting, below which the coal is very tender. In No. 4, at two feet from the bottom, a parting was seen which seems to be persistent. The coal is said to be good throughout. In the vicinity of this pit the section given in Fig. 100 was made out:

100.



1. Limestone, ...		6′
2. Concealed, ...		25′
3. Limestone, ...		2′
4. Concealed, ...		125′
5. Limestone, ...		10′
6. Shale, ...		6′
7. *Coal*, ...		2′ 6″
8. Shale, ...		17′
9. *Pittsburg coal bed*, .		8′
Total, ...		201′ 6″

No. 1 was seen on the hill-top on Mr. Graham's property, where it has been quarried for burning into lime. No. 3 is exposed on Mr. Blair's hill opposite to Mr. Graham's

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and its horizon is shown by a well-marked bench on the latter property. It is said to be the finest limestone in the whole region and occasionally it becomes 4 feet thick. No. 5 is the limestone referred to in the description of the other area of these coals. No use has been made of it and it is usually thought to be inferior. The coal bed below it is given as only 2 ft. 6 in. thick, but the exposure is imperfect and the thickness may be somewhat greater. It is noteworthy that in a distance of less than three miles the interval between this limestone and the *Pittsburg coal bed* has decreased from 47 feet to 25 feet. On the Hauger property the roof shale of the *Pittsburg coal bed* is one foot thick, very rich in carbonaceous matter and contain numerous thin streaks of coal. The top bench of the bed, divided as at other openings already described, is 3 ft. 9 in. thick, and the bearing-in bench is one foot, with well defined slates above and below. No exposure of the coal, No. 7, was seen at any opening except Dr. Hartman's, but the overlying limestone is persistent.

On the pike north from the Presbyterian church and opposite the store, there is a small patch of the *Pittsburg bed*, but being without proper cover the coal is worthless. At a short distance further north is another area, beginning nearly a mile from the church and having a diameter of not far from one third of a mile. It is opened by Mr. Ramsay. The last area at the north is separated from this by a narrow interval and is of like size. Openings were seen here belonging to Mr. Cummings, Mr. Smith and Mr. Cauffield. At the last the bed shows the benches, 32, 22 and 36 inches thick, there being a clay parting between the last two. The general character is the same as at the other pits already referred to. The bed is only 7 ft. 6 in. thick but it is good throughout, as the black shale is wanting and the brown shale rests directly on the coal. The coal of the top bench is the hardest but the middle or prismatic bench is the purest, though very tender. No parting occurs in the bottom bench and the bearing-in seems to absent. Clay-veins are unknown here and the largest horseback extends for only 12 feet along the entry, cutting out but

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18 inches of the coal. At two inches from the base of the top bench there are often found lenticular masses of hard pyritous clay, containing thin streaks of coal. These are from one to five feet long and from one to four inches thick. The clay parting is always pyritous. In Mr. Smith's pit the section is: (Fig. 101.)

1. Black shale, with streaks of *coal*, . .	101.	. . . . . 6″	
2. *Coal*, ...		. . . . . 1′ 10″	
3. Prismatic *coal*, . . .		. . . . . 1′ 11″	8′ 1″
4. *Coal* and partings, .		. . . . . 1′	
5. *Coal*, ...		. . . . . 2′ 2″	
6. *Coal*, very poor, . .		. . . . . 8″	

At one foot below the top of No. 2 there is a six-inch layer of cannel. The top bench is comparatively hard, but the middle bench is prismatic and very tender. Neither horsebacks nor clay-veins are found and the masses of pyritous clay seen in Mr. Cauffield's pit do not occur here. The clay partings are very pyritous and sometimes swell so as to contain layers of pyrites half an inch thick. The bearing-in, No. 4, is coked in heaps and yields a firm coke, which has not much pyrites, as specimens exposed for a year show no irised spots. The section in the Ramsay area is like the last, differing only in that the bed shows but one clay parting.

At none of these openings is the little coal bed seen and the limestone is not exposed in place.

12. St. Clair Township of Westmoreland County.

This is the northern township of the valley, lying on the east side of Fairfield and having the summit of Laurel ridge as its eastern boundary. The synclinal enters it at the Conemaugh about half a mile from below New Florence and the exposed section reaches from 400 feet above the *Upper Freeport coal bed* to the Pocono sandstone.

Along the Pennsylvania Railroad. At the western edge of the township the section shown in Fig. 102 was obtained in a deep cut.

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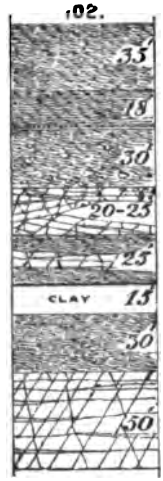

1. Laminated brown to olive shale,	35′	
2. Laminat'd bl'k shale,	18′	
3. Black fossilifer. L. S.,		2″ to 8″
4. Bl'k calcareous shale,	1′	
5. Variegat'd shale, with iron nodules,	30′	
6. Irregular sandstone,	20′ to 25′	
7. Shale and sandstone,	25′	
8. *Philson coal bed*,		6″
9. Variegated clay,	15′	
10. Yellow shale,	30′	
11. Mahoning sandstone,	50′	
Total,	280′ 2″	

Nos. 3 and 4 make up the Black Fossiliferous limestone of the old reports and the whole of No. 2 is fossiliferous. The species are very numerous, twenty having been found during an examination lasting barely fifteen minutes, and the individuals are well preserved. The exposure is complete and occurs near the beginning of the long cut at little more than one-third of a mile below Lacolle station. The fossils are most abundant within four feet above No. 3. In No. 4 only a few crinoidal plates were seen. No. 1 is a non-fossiliferous rock and is dendritic to the distance of somewhat more than three inches from the surface.

In No. 7 the shale continues for about 100 yards along the track, but is suddenly displaced by a sandstone, which seems to have been subjected to strong lateral pressure while resting under the massive rocks above. The little coal bed is known throughout this region as the "Rider" of the *Upper Freeport*. It is thoroughly persistent and is the same with the *Philson coal bed* of Somerset county.

At the mouth of Shannon's run, about a mile below New Florence, an oil-boring was made some years ago. The record has been lost, but Mr. Hoover of New Florence states that the succession of the coal beds is as follows: (Fig. 103.)

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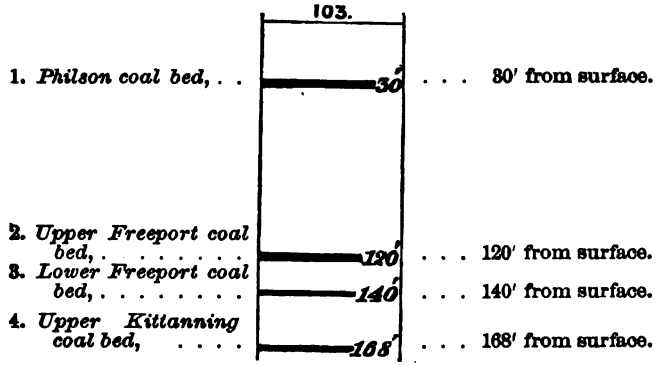
103.
1. Philson coal bed, . .
30'
. . . 30' from surface.
2. Upper Freeport coal bed, ...
120'
. . . 120' from surface.
3. Lower Freeport coal bed, ...
140'
. . . 140' from surface.
4. Upper Kittanning coal bed, ...
168'
. . . 168' from surface.

The intervals between the coal beds being very nearly the same as on the west slope of Laurel ridge though very much less than on the east slope of Chestnut ridge. At a little distance above New Florence, a railroad cut exposes a mass of sandstone and shale belonging to the Lower Barren Series, but its place was not made out. No further exposures were found along the railroad until beyond Nineveh, where the succession shown in Fig. 104 was made out.

This brings the section to the county line and the underlying rocks are described in the report on Cambria county by Messrs. F. & W. G. Platt.

At Nineveh the *Philson coal bed* was reached in a well at 20 feet from the surface; at a little distance further up the road it is but 17 feet, and just beyond Mr. P. Moore's house it comes above the track. The outcrop is insignificant and indicates a bed not more than 6 inches thick, but in Mr. Moore's pit the bed shows:

Coal, ...	4″
Clay, ...	1″
Coal, ...	1′ 5″
Total, ...	1′ 10″

The coal is no longer digged as the bed is too thin to repay working, but is it is said to be a good fuel, burning to a powdery ash and containing no considerable proportion of sulphur. The rocks below it to the sandy shale are irregular. Above the watch-house, No. 6 clearly replaces everything below No. 2 and it may be continuous with that

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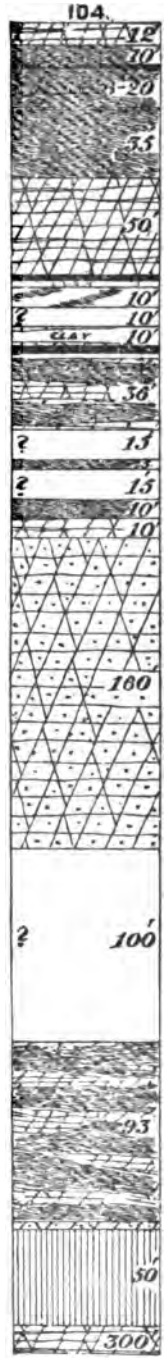

1. Sandstone,	. . . . .	12′
2. Shale,	. . . . .	10
3. *Philson coal bed*,	. . . . .	2′
4. Shale, nodular L. S.,	. . . . .	6′ to 20′
5. Limestone,	. . . . .	1′
6. Sandy shale,	. . . . .	35′
7. Mahoning sandstone,	. . . . .	50′
8. *Upper Freeport coal bed*,	. . . . .	2′ 3″
9. Clay,	. . . . .	3′
10. Clay shale,	. . . . .	10′
11. Concealed,	. . . . .	10′
12. Clay and sandstone,	. . . . .	10′
13. *Lower Freep't c. b.*,	. . . . .	3′
14. Clay,	. . . . .	3′
15. Sandstone and shale,	. . . . .	36′
16. Concealed,	. . . . .	15′
17. Shale,	. . . . .	5′
18. Concealed,	. . . . .	15′
19. Shale,	. . . . .	10′
20. *Brookville coal bed*,	. . . . .	Blossom.
21. Piedmont sandstone,	. . . . .	10′
22. Pottsville conglomerate,	. . . . .	160′
23. Concealed,	. . . . .	100′
24. Mauch Chunk shales and sandstone,	. . . . .	93′
25. Conglomerate sandstone,	. . . . .	3′
26. Silicious limestone,	. . . . .	50′
27. Pocono sandstone, seen,	. . . . .	300′
Total,	. . . . .	968′ 3″

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layer. The clay shale No. 4 is exceedingly calcareous throughout and it may be an argillaceous limestone, broken down on the outcrop to a clay.

The Mahoning sandstone is an irregularly bedded rock, with many large pots of sandy shale. The lower portion tends to be massive, but for twenty feet toward the top it becomes more and more shaly until at last it passes imperceptibly into the overlying shale. The mass is fully exposed and it contains no coal bed.

The *Upper Freeport coal bed* is shown directly underlying this sandstone and has the following structure:

Coal,	13″
Clay, or bony *coal*,	1″ to 2″
Coal,	13″
Total,	2′ 3″

Though so greatly diminished in thickness, the bed shows the same features as at Bolivar, where it is nearly 8 feet thick; the upper division is much broken by very thin partings and the coal is brilliant, while that from the lower division has a dull resinous appearance. The proportion of pyrites is not great and the surface of the coal has no incrustation of copperas.

The Freeport limestone appears to be absent here, though it may occur in the concealed interval, No. 11, but no traces of it were seen. The clay, Nos. 9 and 10, is inferior to that obtained at Bolivar from the same horizon. The *Lower Freeport coal bed* is exposed only by its blossom and no pits have been opened in it.

The sandstone, No. 15, is a crushed and contorted mass and its thickness cannot be determined accurately from the exposures in the cuts. The thickness given in the section was obtained by using the dip of the associated rocks as a basis for calculation. Toward the base, the sandstone is more constant, is very light gray, irregularly bedded and somewhat ferruginous. No. 16 is wholly concealed on this side of the river but Mr. W. G. Platt informs me that a thin coal bed, the *Clarion*, occurs in this interval on the Indiana side.

No. 20 is imperfectly shown in the cut below Conemaugh

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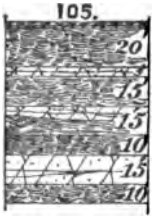
Furnace station, but it was mined years ago on the hill above that station to supply fuel for the furnace. All the openings have fallen shut and no measurements can be made. The old workings were extensive and the bed is said to be from 3 to 5 feet thick, and to yield very good coal.

Conemaugh Furnace station is within the gap of the Conemaugh through Laurel ridge. The top of the Pottsville conglomerate comes down to the railroad track at a short distance below the station but from that point up the river to the county line there are no exposures on the south side of the river. On the northern side the exposures are quite satisfactory and at one locality the conglomerate is shown in a bluff, 160 feet high, though the exposure is not complete, there being short intervals covered by debris. If the sandstone, No. 21, of the section be the Piedmont sandstone, the *Mount Savage coal bed*, belonging between it and the Conglomerate proper, is wanting here. The Conglomerate varies from fine-grained sandstone to moderately coarse conglomerate, but the pebbles are rarely larger than a pea and none was seen larger than a chestnut. The section of the Umbral rocks as far as exposed is as follows: (Fig. 105.)

1. Variegated shale,	5′
2. Sandstone,	1′
3. Variegated shale,	20′
4. Sandstone,	5′
5. Shale,	15′
6. Sandstone and shale,	15′
7. Red shale,	10′
8. Gray conglomerate sandstone,	15′
9. Sandy shale,	10′
Total,	96′

105.



The shales are all reddish and show no fossils. It is evident that the whole of the concealed interval, No. 23 of the section, belongs to this series, for in the fragmentary section just given neither the Mountain limestones nor the iron ores belonging to the upper portion of the group can be found. The Conglomerate sandstone, No. 25, is the same with that found overlying the Silicious limestone at all localities. That limestone has the same character here as in Chestnut ridge and passes almost imperceptibly into the

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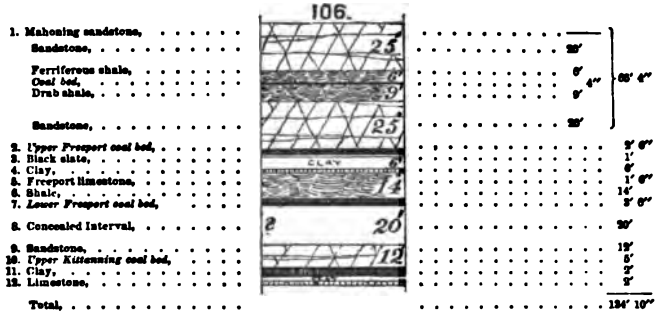
Pocono sandstone below, which is a massive rock, gray and hard, in which no fossils were found.

Laurel run enters the Conemaugh river at a short distance below Nineveh station. The *Brookville coal bed* is mined here, about a mile from the railroad, and is from 3 feet 6 inches to 5 feet thick.

Laurel Hill Run. This enters the Conemaugh just above New Florence. At Hull's mill, two thirds of a mile from that village, the Black Fossiliferous limestone is exposed. On Powder Mill run, a fork of Laurel run, the section represented in Fig. 106 was obtained at a short distance above Laurel Hill furnace:

106.



The sandstones of the Mahoning are much alike, being dull-gray, moderately coarse, and showing some impressions of plant stems. The ferriferous shale is known locally as "blackband," and it certainly contains an appreciable amount of metallic iron. A large quantity of it was digged for use at Laurel Hill furnace, and when a huge stock had been accumulated the owners of the furnace thought well to test the value of the material. The reports disagree respecting the result, some persons asserting that seven tons sufficed to make a ton of metal, while others maintain that fifteen tons of the "ore" yielded a very scant ton of pig. No further use was made of the stock, and it remains on hand for the benefit of future owners of the furnace. The little coal bed seems to be very persistent here, but it is certainly absent at the exposures along the Pennsylvania Railroad.

The *Upper Freeport coal bed* is shown directly under the

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sandstone, which forms a very irregular roof. Only the upper division and main parting of the bed are present here. The lower division, as seen on Chestnut ridge, being absent. The coal is brilliant, in very thin layers, separated by still thinner slates, so that lump coal cannot be gotten out. As fuel this coal is excellent. Coke made from it was used at Laurel Hill furnace for making castings, but it is too sulphurous for use in the furnace, and contains so much dirt as to be tender. No. 3 of the section represents the main parting as found on Chestnut ridge.

The Freeport limestone is poorly exposed. It has a dull bluish gray color on top, but is lighter below. It is said to be only 18 inches thick. Along the outcrop it is replaced largely by iron ore, and as such it was benched for nearly one third of a mile along the outcrop, but the metal obtained from it proved to be quite cold-short.

The *Lower Freeport coal bed* is no longer exposed. No pits have been in operation for many years, but for fifty years after the beginning of the century the coal was industriously mined, and had a high reputation, being known as the "blacksmith's coal." A limestone is said to occur here below it, but no traces were found. The interval between this and the *Upper Kittanning coal bed* is said to be but 28 feet, having been carefully leveled by Mr. Hoover of Laurel Hill furnace.

The *Upper Kittanning coal bed* was seen at an opening, which having been deserted for ten years, afforded no opportunity for measurement. Mr. Winkelmann, formerly mining superintendent for the furnace company, states that the structure of the bed is,

Coal,	2′ 6″
Clay,	1″ to 3″
Coal,	2′ 3″

The coal is said to be very good.

Half a mile further up the mountain a spring was found, which issues from a clay near the Pottsville conglomerate. Some fragments of coal were seen about it, and they may belong to the *Brookville coal bed.*

On the main Laurel run, somewhat south from the last,

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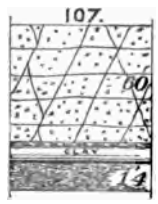
the exposed section reaches only to the *Upper Kittanning coal bed.* The Mahoning sandstone shows the same structure as on Powder Mill, and the *Upper Freeport coal bed* is 4 feet thick. An old opening in this bed was seen, but it could not be entered, and the measurement was made at a poor exposure in the limestone quarry. The Freeport limestone is 3 feet 6 inches thick, dark blue and slaty on top, but light blue to cream colored, and quite pure below. Forty feet below it is the *Upper Kittanning coal bed*, which shows,

Coal,	8″
Clay,	6″
Coal,	2′ 11″
Total,	4′ 1″

The *Lower Freeport coal bed* is concealed.

On Shannon's run, the next south, there are no detailed exposures, and the section as far as seen is the same with that on Laurel Hill run. On a stream entering Tub-mill run at Ross furnace, the *Upper Freeport coal bed* has been mined on the furnace property, but the openings have all fallen shut, so that no measurements can be made. The bed is said to be about 5 feet thick, and to yield good coal.

On the crest of the mountain, near the headwaters of Shannon's, Laurel Hill and Laurel runs, the Umbral ores were mined for Laurel Hill furnace. As that furnace was blown out in 1855, and the mines have lain idle ever since, the exposures are very imperfect. The information respecting the ore was received from Mr. Winkelmann, who discovered the ore and managed the mines. The section is as follows: (Fig. 107.)



1. Pottsville conglomerate, seen,	60′	
2. Greenish-red shale,	2′	
3. Iron ore bed,	6″ to 8″	
4. Clay,	4′	
5. Ore and clay,	1′ 6″ to 8″	
6. Clay,	1′	
7. *Coal bed*,	2″ to 4″	
8. Greenish red shale,	14′	
Total,	84′ 6″	

The Pottsville conglomerate is not fully exposed on any of the runs, but at one locality on Powder Mill run a cliff

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of it was seen having the height given in the section. No. 3 is a poor sandy ore which was not used. Its character is well shown by the many fragments still lying on the surface. The ore of No. 5 is in two layers, of which the upper is usually about two inches thicker than the lower. This ore is a red hematite, occurs in plates, and is of good quality. It was called a three-ton ore, and gave a metal which sold readily for foundry purposes. The mining was extensive, the ore having been benched along its outcrop for a long distance, while tunnels were run through the conglomerate, and the drifts from these were carried out to day-light. In the long drifts under the conglomerate, the ore is said to have retained its hematitic character throughout. No. 8 was found in a prospecting shaft, which unfortunately stopped at the base of the section. It was not carried far enough to determine the presence or absence of other members of the Fayette county series of Umbral ores.

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ECONOMIC GEOLOGY.

CHAPTER XII.

Agricultural Resources — Timber — Water — Water Power.

Agricultural Resources. The soil within the district being almost wholly of local origin varies according to the character of the rocks on which it rests. It is excellent within those areas underlaid by the *Pittsburg coal bed*, but in localities where the surface rocks belong to the Lower Barrens or the Lower Coals, it is, compared with the other, somewhat poor. Since land along the mountain slopes is regarded as of little value, not much of it has been cleared and the ridges are still, to all intents and purposes, a wilderness.

But the method of farming is so negligent that even the rich limestone soils of the Upper Coal areas yield crops no better than those, which with even ordinary care and attention could be obtained from the much poorer soils of the Lower Coal and Lower Barren areas. The average crop of wheat during the best years on the best land falls below 20 bushels to the acre. That this is far below the ability of the soil to produce is well shown by the yield of one lot of 18 acres near Greensburg, which, in 1877, was at the rate of 40 bushels per acre; while another, of 33 acres near New Derry in the Blairsville trough, yielded somewhat more than 30 bushels per acre. The latter farm is only in course of preparation and its owner hopes that, within two or three years, he will have restored it to full fertility.

Throughout this whole region underlaid by the Upper Coals, the soil would produce far above what it does if farmers were only convinced that money and labor invested

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in lime for their farms are certain to bring in an enormous return. Of course, the lime will not bring rain during a season of drought, nor will it cause dry weather during a season of rain, but with it the crop will be able to resist extremes far better than without it. The farmers, for the most part, prefer to farm the land as their fathers farmed it when the soil was new, and they express wonder that the yield falls so far below that which was obtained fifty years ago. But the "heart" of the soil has been farmed out of it, and strength cannot be restored by stable manure, stintedly and grudgingly applied. The only hope is in the application of large quantities of lime at once, to be followed in after years by annual applications of smaller quantities. Information gathered from many persons respecting the condition of their farms leads to the belief that, at most localities, 300 bushels per acre would not be by any means too great in the present condition of the land, and that, in after years, not less than 20 bushels per acre should be added to keep the soil up to a proper standard.

At the base of Chestnut ridge as well as along Brush ridge in Fayette county and along Brush and Huckleberry ridges in Westmoreland, the land is so much inferior to that within the Upper Coal areas, that in the market it is valued at barely half as much and is generally known as the "Barrens." Having been formed from the clayey rocks of the Lower Barrens, containing little sand and hardly any calcareous matter, it is lean and cold. In wet weather it washes and afterwards the surface cracks open during drying. The average crop of wheat within such areas as these is little above 10 bushels per acre, and in many localities such a crop is thought to be a very fine one. But that excellent crops are easily obtained on just such land is well shown by the experiment made near the clay pike in Mt. Pleasant township of Westmoreland, where, by the application of lime in only moderate quantity, the yield was increased from 15 bushels to 25 bushels of wheat per acre. Similar results have been attained in the vicinity of Ligonier, where the value of limestone is so well understood, that land with the Little Pittsburg limestone accessi-

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ble is worth very much more than land without the limestone, or, having it, without means of reaching it.

The defects of soils derived from rocks of the Lower Coal Series are the same with those of the Lower Barrens, though they are less serious in extent, as the soil contains more of sand.

Along the mountain slopes the surface is rough and in many places quite steep, but for the most part the only defect lies in the coating of broken rock. The land is thought to be too rocky ever to repay the cost of clearing; but this is an error, since, in the great dairy counties of New York State, the surface is quite as rough and is encumbered with quite as many fragments as this, or rather it was so encumbered before the farmers took the stones off. The land along these slopes is of undoubted value for grazing purposes, but much of it is too steep to admit of cultivation of grain. For the present, perhaps, it is well that the land is under-rated, for to this undervaluation is due the preservation of the forest.

The distribution of the soils is so distinctly shown on the maps by the colors defining the areas of the several formations, that detailed statement is unnecessary here.

It should not be supposed from the remarks already made that the soil in any portion of the district is what might properly be called poor. There are indeed many farms, which have been farmed so long and without any regard to preservation of fertility, and they are now practically barren and restoration is possible only by the expenditure of much money and labor. But, aside from cases like these, there are no localities within the district in which the land is poor, such that it will not yield largely if cultivated with even ordinary care and skill. Even the so-called poverty-stricken soil of the mountain side in Fayette county, owing its origin to the Pottsville conglomerate and the red shales of the Umbral, has been found by no means inhospitable and it yields fairly good crops, which might easily be increased if small quantities of lime and stable manure were applied each year.

Swamps are almost unknown and the drainage through-

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out the district seems to be almost perfect, so that malarial diseases are of infrequent occurrence.

West from Chestnut ridge all of the ordinary crops can be raised with certainty, but in the highlands of southern Fayette and indeed in the greater part of the Ligonier valley within that county and the southern portion of Westmoreland, the extreme cold of winter renders the cultivation of wheat somewhat uncertain, and the early frosts of autumn are liable to injure the Indian corn. In this elevated region, oats, rye, buckwheat and potatoes are raised in great quantity and the quality of some of these is decidedly excellent.

The "Barrens," marking the course of the Saltsburg and Blairsville anticlinals throughout Fayette and Westmoreland county, are well adapted to fruit raising, and the hills along the Youghiogheny and Monongahela, bearing a somewhat similar soil, are celebrated for the excellence of the grapes and other small fruits growing upon them.

Supply of Water. The whole district is well supplied with water for farming and domestic, as well as for the ordinary manufacturing purposes. A glance at the maps shows that, in every township, several small streams are represented, while there are many others, too small to be placed on the map, which are of much importance to the stock-raiser. Springs are very numerous and usually the water is good, though in a large part of the district it is quite hard. Soft water has been obtained at several localities by boring to well-marked sandstone horizons in the Lower Barrens, but there is no certainty that borings reaching those horizons would prove invariably successful in securing soft water. Much no doubt depends on the character of the soil where the rain-water enters these rocks.

Water-power. Though water-power has been almost superseded by steam, yet its cheapness is such that it will be applied whenever the supply of water is constant and the fall sufficient. The water-power should be included among the valuable resources of the district.

The fall of several streams is shown approximately by the railroad levels. Thus, from Conemaugh Furnace station

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at the east side of the Ligonier Valley to Bolivar at the west side, the Conemaugh falls 102 feet. On the same river the fall from Blairsville Intersection to the Allegheny at Freeport is nearly 200 feet. In seven miles below Ligonier, the Loyalhanna falls somewhat more than 100 feet, while Mill creek, one of its tributaries, has a fall of more than 200 feet in the last four miles of its course. The Youghiogheny river falls 350 feet from the Ohiopyle Falls to Connellsville, a distance of barely 17 miles, while from Connellsville to the mouth of the river at M'Keesport the descent is about 140 feet. On all these streams except the Loyalhanna the banks are high and the water can be thrown back without danger of overflowing valuable property.

Streams flowing from the mountains are for the most part of uncertain value, but there are some within the district on which dependence can be placed throughout the year. The descent of Sewickly creek from the crossing of the Southwest Railroad to the Youghiogheny river is 150 feet and is quite as regular as that of the Youghiogheny river below Connellsville; that of Redstone creek from Uniontown to the Monongahela is approximately 130 feet; while that of Jacob's creek, almost midway between those already given, is upwards of 300 feet from Scottdale to the Youghiogheny river. So that on these streams water-power of great value exists. On the smaller streams flowing from the mountains, the fall in many cases is enormous and the mass of water during spring is immense, but during the greater part of the year they are so low that the grist and saw-mills on their banks cannot run.

The water-power at Ohiopyle Falls on the Youghiogheny is well known. In 1825, Congress appointed a commission of army engineers to select a site on the western waters for an armory. Twenty sites in all were examined by the commission, but the preference was given to that of Ohiopyle Falls, though owing to its inaccessible position at that time it was not selected. The report of this commission describes the site with great detail and a few of the features may be mentioned here.

The river makes a circuit of about two miles round a

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projecting tongue of land. At the upper side of this tongue is the commencement of the falls and rapids, which terminate on the lower side at a direct distance of little more than 600 yards from the commencement, and the whole descent is 87 feet, 6 inches. The ground on the lower side, next the foot of the rapids, is disposed advantageously in benches of sufficient width and at convenient distances below each other for erection of buildings and successive application of the water to machinery, as may be desired. To convey the water from the upper side to this site, a canal would be necessary, of which the first 400 yards would pass through a strip of river "bottom," while the rest would have to be excavated across the neck of the peninsula. At the time the commission reported it was supposed that the excavation would be wholly through rock; but since that time a deep cut has been made for the railroad at a little distance back from the line proposed for the canal, which shows that at one time the river flowed directly across the neck of the peninsula, as indeed is apparent from the surface further out on the neck. It is evident, therefore, that the rock excavation would be insignificant as compared with the estimate made by the commission, in which it is placed at 3,660 cubic yards. The commission estimated that a dam four feet high, built across the river at the commencement of the rapids, would suffice to procure depth of water in the canal, sufficient to prevent choking by ice or drift; and the quantity of water thus made available was regarded as exceeding 100 cubic feet per second even in an excessively dry season.

But little advantage is taken of any portion of this power which is now thoroughly accessible, being on the line of the Baltimore and Ohio Railroad, Pittsburg Division. At Ohiopyle station, the falls themselves are utilized in part, three extensive mills being driven by turbine wheels, which are run with 34 feet of fall.

Forest Growth and Timber. West from Chestnut ridge, the woodland covers but a small portion of the surface, though the area so covered is much greater than one, casually riding over the country, would be apt to suppose. A

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similar condition exists in the Ligonier Valley within Westmoreland county, but in the southern part of that valley as well as along all the mountain slopes most of the surface is still covered by the original forest, which has much excellent timber, consisting of oak, chestnut, poplar or tulip tree, ash, maple, hickory, locust, wild cherry and beech. A little pine occurs at some localities.

Except along the east base of Chestnut ridge, but little wood is consumed for fuel, as in nearly all portions of the district coal is readily accessible and can be mined very cheaply. But in many places, now densely covered by trees, the original forest and even a later growth were removed to provide charcoal for the numerous furnaces engaged in reducing the iron ores. This occurred on a large part of both slopes of Chestnut ridge in Fayette county and at many places on Laurel ridge within Westmoreland county. As most of these furnaces went out of blast many years ago, the new wood is of by no means insignificant size.

The woodland in the more thickly settled portions of the district is carefully preserved and, as but little of the mountain land is brought under cultivation, the forest seems to be undergoing no change. But along the lines of the three great pikes, as well as near the railroads, great destruction of the more valuable wood is going on. Many men are wasting their substance by making poor shingles out of excellent oak, while others are doing the same thing by selling blocks of oak to stave manufacturers, who ship their product to be made up into barrels elsewhere. As this waste is not sufficiently rapid, large oaks are stripped of their bark, which is sold to tanners, while the wood is suffered to rot. Locust is so excellent for fence-posts that it soon disappears from one's property, and the demand for the wood is so great, that there are not wanting persons to invade another's land in search for it. Walnut commands a so high price that, wherever any means of transportation are available, the trees are promptly cut down and taken away. The poplar is quickly used up in this land of portable saw-mills, for those are as destructive to good timber

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as a cloud of locusts is to a wheat-field. The beech being practically useless for anything except fuel, is permitted to remain and it is rapidly becoming the dominant tree on the mountain slopes.

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Chapter XIII.

The Coal Interest.

This topic may be considered most conveniently under three heads, coal for local use, for shipment, and for coke.

I. Coal for Local Use.

In Allegheny and northwestern Westmoreland, where the Waynesburg and Nineveh troughs are reached, the *Pittsburg coal bed*, owing to the northward rise of the strata, lies high up in the hills, but, except along the Allegheny and Conemaugh rivers within Westmoreland county, the country is not cut deeply enough to expose the *Upper Freeport coal bed*. As the Lower Barren Series contains no coal beds of available thickness in these troughs, the chief dependence is upon the *Pittsburg coal bed*, which occurs in patches on the high hills of eastern Allegheny and in limited areas within northwestern Westmoreland. The coal is of excellent quality and the bed lies in such shape, that the inhabitants of the region can procure fuel at reasonable rates and without serious difficulty. The quality of the coal will be referred to in another portion of this chapter.

Within the same region, the *Upper Freeport coal bed* is reached on the Conemaugh and the Allegheny. Its coal is decidedly inferior to that from the *Pittsburg*, in part because of the presence of more ash and sulphur. It is harder than that from the *Pittsburg*, but is brittle and apt to break down into slack, so that the other is more conveniently handled. At the same time it is far from being a poor fuel and, for some purposes, it is thought better than *Pittsburg* coal. This bed is of no small importance as it supplies a very considerable area, which otherwise would be awkwardly placed for fuel.

The Lisbon or Irwin trough, which lies next east from the last and extends from the Conemaugh to the mouth of

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the Cheat river, is abundantly supplied with coal throughout its whole length. In the extreme northern portion, the *Upper Freeport coal bed* is readily accessible along Beaver run, the Conemaugh and the Loyalhanna, while, at a few miles south, the northern outcrop of the *Pittsburg coal bed* is reached. As this bed is high in the hills north from the Pennsylvania Railroad, it is available at almost all localities there. The *Elk Lick coal bed* is reached on Beaver run and is of workable thickness, though, owing to the accessibility of the *Pittsburg*, it is not mined.

South from the Pennsylvania Railroad, the *Pittsburg coal bed* is considerably below the surface at the central line of the trough, but, within Westmoreland county, the area between the outcrops of this bed is so narrow that coal can be obtained easily by hauling but a short distance. But within this area the *Redstone coal bed* becomes available and is of workable thickness in southern Westmoreland and northern Fayette. It yields a good coal, which is inferior to that from the *Pittsburg* only in respect of ash. As the bed is from 3 to 4 feet thick, it can be worked to advantage where the other is not readily accessible.

South from the line of the Little Redstone creek, the *Waynesburg coal bed* is reached in the hills and becomes of thickness to render it valuable. It is mined quite extensively for domestic use on Redstone and Dunlaps creeks and yields a coal, which, though very much inferior to that from the *Pittsburg* in respect of ash, is nevertheless good for domestic purposes, as it is free-burning and therefore convenient. The principal drawback lies in the presence of thick bands of clay, which break up the bed into benches in such a way as to render the getting out of clean coal somewhat uncertain, and the amount of impure material is liable to be greatly increased beyond what is shown by analyses of the coal. Care is needed in selecting at the bank, so as to avoid gross admixture with slate.

Further south in this trough, the *Sewickley coal bed* attains to workable thickness, and, near the mouth of Cheat river, the *Redstone coal bed* is occasionally thick enough to be mined. These beds yield a coal far superior to that from

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the *Waynesburg*, yet not so good as that from the *Pittsburg*. But they are not mined to any considerable extent, since, where they are available, the *Pittsburg* bed is within easy reach.

In the Greensburg trough, which occupies the north central portion of Westmoreland county, the *Pittsburg coal bed* is the only source of supply on which reliance can be placed. The bed is easily accessible along a long line of outcrop and everywhere yields excellent coal. A small coal bed above it is sometimes thick enough to mine in the vicinity of Greensburg, but its coal, as compared with that from the *Pittsburg*, is so inferior that it is thought fit only for burning lime. The *Upper Freeport* is reached on the Loyalhanna and the Conemaugh near the edge of this basin.

In the Blairsville basin, which reaches the whole length of the district from the Conemaugh river to the line of West Virginia, the *Pittsburg coal bed* is available throughout. The space between the two outcrops of that bed is so narrow that no other has received much attention. Within Westmoreland county, except near Jacob's creek, no higher member of the Upper Productive Coal Series is of any value, but south from that creek in Fayette county, the *Redstone*, and occasionally the *Sewickley*, are good and valuable beds, whose importance is as yet wholly unconsidered as the *Pittsburg* is so easily reached.

Aside from these beds, the important beds of the Lower Productive Coal Series are available along the western slope of Chestnut ridge. They have been almost wholly ignored, and have been worked to but a slight extent, and only by a few farmers living on the mountain side. Those, thus mining and using these coals, are viewed with a feeling almost akin to pity by many, who live in the valley and regard the mountain coals as little better than slate. But no belief could be much more erroneous than this, for the coal yielded by the *Upper Freeport* and the *Brookville* is of very good quality, so that, though it may not be equal to the demands of shippers, it is an excellent fuel, almost as clean as the *Pittsburg* coal, and really inferior to it only

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in respect of sulphur. It is soft, but not softer than that from the *Pittsburg*, which in this basin is too tender for shipment, and can be utilized only in the manufacture of coke. The *Upper Freeport coal bed* is present along the face of the ridge, all the way from the State line to the Conemaugh, and shows no serious irregularity in thickness. The *Brookville coal bed*, though equally persistent with the last, varies materially in thickness.

To those owning land underlaid by the *Pittsburg coal* south from the Youghiogheny river, the consumption of coal from that bed for fuel is a matter which calls for serious consideration. The future of that portion of the basin as a region for the production of good iron at low rates is exceedingly promising. The supply of ore immediately below the *Pittsburg coal bed* is very great, and an equal or perhaps greater amount is available from the mountain beds. The coke for reducing this mass of ore must come from the *Pittsburg bed*, and the amount of coal within the area referred to is barely sufficient to reduce the ore directly under that bed. If, therefore, that coal be used for fuel or manufactured into coke for shipment, it is inevitable that, at no very distant day, this district will be compelled to purchase coke from other localities with which to make its iron.

Within the Ligonier Valley the supply of coal is ample to meet all domestic wants. The *Pittsburg bed* occurs in limited areas within Westmoreland county north from Loyalhanna creek, and yields a fuel of certainly very excellent quality. Analyses of this coal have been given in the chapter on the Upper Productive Coal Series. The coal is softer than that from the same bed in the Blairsville basin, contains, as a rule, rather more sulphur, but about the same proportion of ash. It is therefore unfit for shipping, and still less fitted for the manufacture of coke.

Within Westmoreland county, the *Upper Freeport coal* is readily accessible on both sides of the valley, and on the east side the *Lower Freeport* and *Upper Kittanning* beds are occasionally worked. Owing, however, to the proximity of the *Pittsburg bed* the others are but little mined, except

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in the vicinity of the Conemaugh river. They yield coal, which is good for domestic use, though for the most part they contain too much sulphur, and are too tender to be available for shipment. In the southern portion of the county, where the *Pittsburg coal bed* is too far away to be reached conveniently, the *Lower Kittanning*, and occasionally the *Clarion* bed are mined along the east side of the valley, while the *Upper* and the *Lower Freeport* are used on the west side along the base of Chestnut ridge.

In Fayette county, within this valley, the Upper Productive Coal Series is not reached, and the dependence is solely upon coal from the Lower Productive Series. The *Upper Freeport bed* is accessible along Indian creek from the county line southward through Salt Lick, and much of Springfield. Near the Youghiogheny river, on the north side, it occurs in patches, but south from that river it is readily accessible for long distances along Meadow run, Big and Little Sandy, as well as on other streams.

Near the deep trench made by the Youghiogheny river, beds below the *Upper Freeport* are exposed, and some of them are of no small importance. The *Lower Freeport*, the *Lower Kittanning* and the *Clarion* are mined, and they all yield coal which answers well for fuel.

A few analyses of coals from the Ligonier Valley were made. The quality of the coal being clearly such as unfits it for commercial purposes, an extended series of analyses was thought unnecessary. The results are as follows, the analyses having been made by Mr. A. S. McCreath in the laboratory of the Survey at Harrisburg:

I. Upper Freeport coal bed, Cook T., Westmoreland Co., Mr. Lyon.

II. Upper Freeport coal bed, Springfield T., Fayette Co., Fayette Furnace.

III. Upper Freeport coal bed, Stewart T., Fayette Co., Samuel Potter.

IV. Lower Freeport coal bed, Stewart T., Fayette Co., M. Mitchell.

V. Lower Kittanning coal bed, Ligonier T., Westmoreland Co., R. Hall.

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VI. Lower Kittanning coal bed, Springfield T., Fayette Co., Fayette Furnace.

VII. Clarion coal bed, Stewart T., Fayette Co., George Potter.

	I	II	III	IV	V	VI	VII
Water,	0.770	0.930	0.870	0.700	0.780	0.880	0.860
Volatile matter,	23.910	24.545	27.255	25.470	20.405	21.815	28.490
Fixed carbon,	64.526	69.956	61.759	54.673	69.570	59,417	65.570
Sulphur,	4.789	1.414	2.031	3.673	3.295	4.398	2.025
Ash,	6.005	3.155	8.085	15.485	5.960	13.510	5.055
	100.000	100.000	100.000	100.000	100.000	100.000	100.000
Coke, per cent.,	75.320	74.525	71.875	73.830	78.815	77.325	72.650
Color of ash,	Pink.	Gray.	Gray.	Gray pink tint.	Pink.	Gray pink tint.	Red.

It will be seen from this review that the whole district is abundantly supplied with coal for fuel. There are few localities where coal cannot be obtained, within two or three miles, from pits now in operation, and except in the southern part of the Ligonier valley, where only the Lower Coals are accessible, one, desiring to burn only coal from the *Pittsburg bed*, would have to haul it not more than seven or eight miles.

In this summary, no note has been taken of any beds less than three feet thick, for in this district coal is so abundant and so well distributed that any bed less than three feet thick is thought to be of no value whatever, and, for the most part, anything less than five feet thick is regarded as insignificant and is spoken of as a thin bed.

A comparison of these with coals obtained in the western States shows that this district is highly favored not only in the abundance but also in the quality of its coal. In the first volume of the Illinois report the results of 50 analyses of coals are given, which show that in nine cases the ash exceeded 10 per cent., in one being 37 per cent., while twenty-four others show upwards of 5 per cent. The moisture in thirty-four exceeded 10 per cent. and in twenty-three others it exceeds 6 per cent. In the Missouri report for 1872, the results of 82 analyses are given. In 31

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of these, the ash exceeds 10 per cent., and in thirty-three, exceeds 5 per cent. In seven the moisture exceeds 10 per cent., and in fifty-five others is more than 5 per cent. In Dr. White's report on Iowa, the results obtained by Dr. Emery show that, in two counties, the average of ash is more than 10 per cent., while that in eleven others is more than 5 per cent. In six counties the average per cent. of moisture exceeds 10, and in four others it is more than 5. The poorest specimen from the Fayette and Westmoreland district shows but 15 per cent. of ash and considerably less than 2 per cent. of moisture.

II. Coal for Shipment.

Throughout the Fayette and Westmoreland district, the coal is bituminous and that, which is mined for shipment, is obtained exclusively from the *Pittsburg* bed. The variations in character shown by this bed are such that good shipping coal can be got only from the Lisbon, Waynesburg and Nineveh troughs. In the Greensburg and Blairsville troughs, the coal is too soft to bear much handling and, as it contains less volatile combustible matter than that from the more western troughs, it is not so well adapted for the manufacture of gas.

In the extreme northwestern portion of the district, the *Pittsburg coal bed* lies high in the hills, as indeed it does in the greater portion of eastern Allegheny county. Within this area, which includes parts of the Waynesburg and Nineveh troughs, the coal is easily accessible on all sides, and the deep ravines cutting into the hills afford ample opportunity for low grade narrow-gauge railroads, by which to reach the river or the Pennsylvania Railroad. A large part of the region north from the Pennsylvania Railroad is controlled by the New York and Cleveland Gas Coal Company, which, having a long front on the Allegheny river, gains a great share of the shipments to northern points. But this trade is shared by other large concerns, whose works are on the west side of the area, facing the river and the railroad.

South from the Youghiogheny river in Allegheny county,

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but little has been done in the way of shipment except along the Monongahela river, where the coal is above water level all the way from the line of Fayette county to Pittsburg, and the trade is almost wholly confined to supplying the lower ports along the Ohio and Mississippi. There are extensive coal-works on the Youghiogheny near its mouth, as the slack water of the Monongahela reaches for several miles up the other stream.

In the Lisbon or Irwin trough, the two great coal companies of western Pennsylvania control nearly all of the available coal land from the Pennsylvania Railroad to the northern outcrop of the bed, and also much between the railroad and the Youghiogheny river. The Westmoreland Coal Company has extensive mines at Larimer, Irwin, Manor and Penn on the railroad, and has opened large works on the Baltimore and Ohio Railroad near the line of Allegheny county; while the Penn Gas Coal Company has equally extensive mines at Irwin and Penn on the Pennsylvania Railroad, as well as at several points on the Youghiogheny Railroad, which the company built from Irwin to Sewickley on the Youghiogheny river.

On the Youghiogheny river, the *Pittsburg coal bed* passes under the stream at a little way above the mouth of Sewickley creek and does not come up again until within a short distance of the Fayette county line. No important mines are in operation above West Newton along this river. Formerly when this stream was slacked, coal could be sent out as readily as it can now from points on the Monongahela and coal-works lined both sides of the river. But the dams were suffered to go to decay, and now no coal is available except that on the left bank where the railroad can be used for transportation.

Along the Monongahela there are some extensive coal-works on the northwestern outcrop, but on the southeastern side of the trough there are few as the coal is materially changed in character.

In the greater part of this basin the coal is a typical gas coal. The following analyses show its character at a num-

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ber of localities. The order is from the south towards the north.

I. J. Slocum, Brownsville, Fayette Co., average of four. (A. S. McCreath.)

II. A. Townsend, Perry T., Fayette Co. (D. McCreath.)

III. Westmoreland Coal Co., average of three. (A. S. McC.)

IV. Penn Gas Coal Co., average of three. (A. S. McC.)

V. Saltsburg Coal Co., Loyalhanna T., Westmoreland Co. (D. McC.)

	I.	II.	III.	IV.	V.
Water,	1.252	0.890	1.427	1.517	1.070
Volatile matter,	36.551	34.545	37.980	36.873	35.515
Fixed carbon,	55.586	59.450	54.598	57.288	56.458
Sulphur,	.879	0.895	0.638	0.710	2.257
Ash,	5.732	4.220	5.357	3.612	4.700
	100.000	100.000	100.000	100.000	100.000
Per cent. of coke,	62.197	64.365	60.593	61.610	63.415
Color of ash,	. . . . .	Red-gray.	Red-gray.	Cream.	Red-gray.

But near the State line the proportion of volatile matter is diminished to correspond with the marked change in the structure of the bed itself, which there is similar to that observed in the Blairsville trough. The coal is softer and does not bear handling well, so that it is better fitted for manufacture of coke. Otherwise it is not inferior.

Along the line of the Pennsylvania Railroad, some coal is shipped from the Blairsville and Greensburg basins, but for the most part the mines are worked for the manufacture of coke or to supply fuel to the surrounding country. The same statement may be made respecting the coal in the Blairsville basin along the Youghiogheny river, though there, owing to necessity, not a little is shipped to points east from Connellsville along the Baltimore and Ohio Railroad.

As much of the *Pittsburg* coal is shipped not only for the manufacture of gas but also for fuel along the line of

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the Ohio and Mississippi rivers, it would be interesting to compare it with others with which it must compete. Unfortunately the records of experiments on the combustible value of coals are few and, for the most part, they are far from being satisfactory, owing to the limited quantity of coal used in the tests. Experiments made quite recently by the Pennsylvania Railroad Company have shown that the coal from the extreme northern portion of the Irwin trough is unexcelled, for producing steam, by any bituminous or semi-bituminous coal, so that it is transported by that company from the Conemaugh river in northern Westmoreland county to Jersey City, to be used on passenger engines drawing the fastest trains between New York and Philadelphia.

Comparison with analyses of coals from other portions of the country, especially of bituminous coals from the western States, show the *Pittsburg* coal, even that from the Blairsville trough, to be vastly superior as fuel to that which is obtained from by far the greater number of western localities.

This whole region is most admirably supplied with means of transportation. The Pennsylvania and the Baltimore and Ohio Railroads afford ample opportunity for shipment eastward, numerous roads from Pittsburg open up access to the northwest, while the Ohio river brings within reach the most important market of all, the great cities along that river and the Mississippi.

This coal, known along the rivers as Youghiogheny coal, is so good that it will always find a ready market for use as fuel, while there is little probability that any other coal can successfully compete with it as a gas coal.

But though the market is always reasonably certain, it is not capable of absorbing an unlimited quantity, as operators along the Monongahela and the lower Youghiogheny have ascertained to their loss. During the time of inflated manufacture, preceding 1873, there seemed to be no limit to the capacity of the market; the price of coal went to 10 cents per bushel, new works were begun along all lines of transportation and old works were greatly increased in ca-

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pacity. The Monongahela river is lined with coal-tipples from the mouth of Turtle creek to Brownsville, and there are huge works along the lower Youghiogheny as well as in the vicinity of Pittsburg. The amount of land thus opened up is enormous, and doubtless the works now in operation or that can go into operation within a few days' notice are sufficient to supply the market for many years. Even now the annual production exceeds the actual demand; many of the larger works are running at far below their capacity and the safety of the trade seems to depend in great measure upon reducing the production to below the present rate.

III. Coal for Coke.

Coal from the *Pittsburg* bed in all portions of this district makes an excellent coke, since, except at rare localities, it contains little sulphur and a low percentage of ash. That from some other beds has been tested but the coke proved to be tender even when otherwise good, so that the sole dependence is placed upon the *Pittsburg* bed.

In the Lisbon trough, Messrs. Carnegie & Co. have erected a number of ovens on the line of the Pennsylvania Railroad west from Larimer station, where they use slack obtained from mines of the Penn and Westmoreland Companies at Irwin and Penn. This slack is washed and yields a coke of very superior quality. On the Youghiogheny river within the same trough, quite a number of firms have erected ovens to utilize the slack which otherwise would accumulate to such an extent as to be very inconvenient. At Brownsville, on the Monongahela river, the slack is utilized in a similar manner. At all of these localities except the first the slack is used unwashed and yields a firm and very compact coke. Fragments of slate, however, render it hardly clean enough to be employed in furnaces for the reduction of iron ore. In this basin, the slack alone is used because the coal itself is hard and bears shipping well, so that a ready market can be obtained for it in that shape. But the manufacture of coke from the lump coal could not be carried on here in competition with works in the Blairs-

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ville trough, because of the greater proportion of volatile combustible matter. In the Blairsville basin the volatile matter rarely exceeds 31 per cent., whereas in the Irwin trough it frequently exceeds 37 or 38 per cent. The proportion of coke per ton of coal is therefore much less in the latter than in the former.

In the Ligonier Valley some attempts were made to ascertain the value of the *Pittsburg* coal for coke. There the coal contains little more than 25 per cent. of volatile matter and only a moderate amount of ash. It cannot be shipped, as it is too friable to bear handling. It cokes readily and yields a compact coke, which seems to be good and is said to have worked well in the old Hillsview furnace, north from the borough of Ligonier. But the analyses show that, as a rule, the coal contains too much sulphur for good coke. At the same time the analyses are probably too few to settle finally the value of the coal for this purpose, and it might be well to make a series of careful tests at ovens, so as to ascertain the series of coke. If this can be proved to be a good coking coal, the little areas left in the valley will prove quite valuable, as they are easily accessible by the Latrobe and Ligonier Railroad, while the increased proportion of coke due to the diminished percentage of volatile matter, would make the manufacture profitable at rates so low as to be little more than sufficient to pay ordinary expenses in the Blairsville trough.

Along the Monongahela river in the southern portion of the Lisbon or Irwin trough the structure of the *Pittsburg* bed is different from that shown in the northern portion of the same trough. South from Brownsville it approaches that observed in the Blairsville trough. With this change in structure comes the corresponding change in composition and the attendant diminution in the percentage of volatile matter. It has been thought that the coal here would do well for the manufacture of coke, and extensive coke works have been erected at the mouth of Cats run on the Monongahela, nine or ten miles below the State line. Analyses of coal from this vicinity show that volatile matter is present in but slight excess above that in the Blairsville trough, so

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that the yield of coke is likely to be but little less than in the latter. But in the transition structure, the slates are thicker than in the Blairsville basin and the "bearing-in" slates are apt to be present for considerable distances, so that the coke, though really quite as good and clean as that from the coke basin proper, is not apt to find so ready a market, owing to the injury which the projecting bits of slate do to its appearance. Aside from this defect, the coke made here is good, contains little sulphur, is very compact and is not inferior to that made in the coke basin. An analysis of coal from this vicinity shows the following to be the composition (D. McCreath):

Water,	1.040
Volatile matter,	32.815
Fixed carbon,	60.241
Sulphur,	1.249
Ash,	4.655
	100.000
Per cent. of coke,	66.145
Color of ash,	Gray.

While a coal from Redstone creek, near the eastern outcrop of the bed, shows a very similar composition.

The Coke Basin, as generally understood, is co-extensive with the Blairsville trough, where the *Pittsburg coal* is tender, has a resinous luster and contains only from 30 to 32 per cent. of volatile matter with from one half to little more than one per cent. of sulphur. The area is narrow and is deeply indented by streams, so that the line of outcrop is long and irregular.

Analyses of the coal from this basin, as given in report KK, show remarkable constancy in the composition and would lead one to suppose that the coal in all parts of the trough is of nearly the same quality. But the analyses fail to tell the whole story. Examined physically or chemically the coal at the Conemaugh is apparently the same with that obtained at the Youghiogheny, yet on the latter stream the coke is compact, silvery and retains its luster for an indefinite period on exposure, whereas that made from coal near the Conemaugh or at any locality north from

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the Pennsylvania Railroad is comparatively tender, dull looking, and on exposure it soon loses the little luster that it has. Yet the same coal if washed, produces a coke of extreme excellence as has been well shown by experience at Lucy furnace near Pittsburg. Coke made at Coketon in Westmoreland county proved wretched and the working of the furnace was very irregular; but, since washing machines have been introduced, the coke has proved superior to that obtained from the Connellsville region and the furnace has made some extraordinary runs. If this washing renders the coke better than the typical coke of Connellsville, the product should have an increased value, which ought to be sufficient to compensate for the slight additional cost.

This variation in the coal seems to have been discovered at an early day in the history of coke manufacture, for the coke-making area is confined to that portion of the trough which lies south from Sewickley creek, and the works are by no means important until one comes near to Jacob's creek. Thence southward to near Uniontown in Fayette county the eastern outcrop of the bed is lined with coke ovens. There appears to be an unwarrantable prejudice in favor of the eastern outcrop, and several manufacturers have told me that the coal on the western outcrop is somewhat inferior. The facts do not afford any basis for this prejudice. The extensive coke-works near Dawson on the Youghiogheny river are upon the extreme western outcrop, but the coke made there is not inferior to any made along the eastern crop from Mount Pleasant to Lemont furnace.

The coke is burned in beehive ovens and the period varies from forty-eight to seventy hours. The process of manufacture has been fully described by Mr. Franklin Platt in the Coke Report and no reference to it is necessary here.

The present condition of the trade is that of extreme depression and coke is selling at less than two cents per bushel at the works. This is barely sufficient to pay the cost of making, allows nothing for wear and tear of property or the cost of the coal itself. Many of the works are not in operation.

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The coke manufacture is wasteful in the extreme and those owning extensive tracts of land south from the Youghiogheny river have already done themselves almost irreparable damage. The coal has been worked out from large areas underlaid by the valuable *Pittsburg* ores, which at an early day will be in demand for iron-making; for as will be shown in a succeeding chapter, there are few localities within our country so highly favored with all advantages for cheap manufacture of a good iron. It would be well for those having coke ovens here to stop all further production, and the furnaces themselves having been built on properties which had already suffered sad depletion of their coal resources, would do well, in the present depressed condition of the trade, to purchase coke and to husband the coal now remaining on their properties.

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Chapter XIV.

Historical Notes Respecting the Old Furnaces of Fayette and Westmoreland Counties.

I. The existence of valuable iron ores underlying the *Pittsburg coal bed* was early discovered in Fayette county and, not much later, the ores of the Umbral group were found in the gorges and along the crest of Chestnut ridge within the same county, as well as along the west face of Laurel ridge in Westmoreland county.

It is quite clear that the oldest furnaces west from the Allegheny mountains are those which were erected in Fayette or southern Westmoreland. In the history of iron manufacture in this country Mr. J. B. Pearse states, that in 1777 or 1784 Mr. Oliphant, Sr., erected the Mary Ann furnace at some locality in Greene county, about thirty miles from Uniontown. This statement, for which Mr. Pearse is unwilling to vouch, is certainly inaccurate, for Mr. F. H. Oliphant says that no such furnace was erected by his father and that, as far as his knowledge goes, there never was any furnace in Greene county.

Mr. Pearse states that the Blue Lump ore under the *Pittsburg coal bed* was discovered by John Hayden in 1789. The material was supposed to be limestone, but as it would not slake after burning and was very heavy, it was tested for iron in a smith's forge, the test yielding a piece of iron "as big as a harrow tooth." Mr. Hayden came east to procure money and was joined by State Comptroller John Nicholson. They took up tracts at the base of Chestnut ridge and, as Mr. Oliphant states, established a bloomery, which was soon succeeded by Fairfield furnace, built in 1792 near where Fairchance furnace now stands. This firm failed, owing to the defaulting of Nicholson, and the property fell into the hands of the Oliphant Brothers about the beginning of this century.

But before this time (Pearse), Mr. W. Turnbull of Philadelphia, Peter Marmie and John Holkar, consul-general of

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France, had erected the Alliance Iron Works at the mouth of Jacob's creek to work the Barren Measure ores, which occur there in considerable quantity. This furnace went into blast in 1790 and remained in operation until 1795. About the same time Isaac Meason and Moses Dillon built Union furnace on Dunbar creek, very near the site of the present Dunbar furnace. The venture proved very successful, and Mr. Meason afterwards built other furnaces in the same neighborhood, first rebuilding the old furnace in 1793, according to Mr. Pearse, or 1796, according to Prof. Lesley.

In 1789, Mr. John Hayden made the first wrought iron manufactured west from the Alleghenies. In 1791 the Alliance works cast cannon balls for the defense of Pittsburg, and in 1793 for General Wayne's expedition against the Indians (Pearse). The furnaces made castings and the business was very profitable, as, according to the statement made by Mr. Pearse, the price of castings was thirty-five pounds per ton.

In 1792, Mr. John Probst built Westmoreland furnace on Furnace run at the base of Laurel ridge, nearly four miles southeast from the borough of Ligonier in Westmoreland county. This furnace depended on an ore belonging to the Brookville group, probably equivalent to the Jude ore of southern Fayette county. A forge was built before 1800, but the iron proved to be poor and the concern remained in operation for but a few years. In 1794, Old Laurel furnace was built by Joshua Gibson and Samuel Paxson on Laurel run in Dunbar township of Fayette, near the east base of Chestnut ridge. It afterward passed into the hands of Reuben Mochabee and Samuel Wurtz, who, in 1800, built Hampden forge on Indian creek, half a mile from the Youghiogheny river. The furnace was kept in operation until 1812 and the forge was not abandoned until 1825.

In 1800, Messrs. Lewis and Squires built the Mary Ann furnace near Haydentown in Fayette county. This was a small furnace, with a capacity of barely a ton and a half, and depended on the Pittsburg Blue Lump, which was

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hauled four miles. In later days the furnace passed under the control of Mr. Victor, who used the Umbral ores, which were more conveniently reached than those under the *Pittsburg coal bed.* This furnace was abandoned a number of years ago. In the same year, Mr. J. Huston erected Redstone furnace on a branch of Redstone creek, in South Union township of Fayette, to work the Blue Lump, which is present in large quantity in that vicinity. This furnace made from one to two tons each day and remained in operation until 1870.

The year 1800 seems to have been a busy one for the iron men of southern Fayette county, for in that year Messrs. J. Hayden and Company built Fairchance furnace, on George's creek, a small stack of similar capacity to the others already mentioned. In 1805, the firm became embarrassed, and the property passed into the hands of Messrs. J. & A. Oliphant, who, in company with Mr. A. Breading, had already obtained control of Fairfield furnace. By these gentlemen, the furnace was enlarged so as to make three tons of iron each day. The only ore then used was the Blue Lump, but in 1817, under the management of Mr. F. H. Oliphant, the other ores under the *Pittsburg coal bed,* then only recently discovered, were used in addition to the Blue Lump. This furnace remained in possession of Mr. F. H. Oliphant until 1870, always successful, and always producing an iron of remarkably fine quality at low cost. In that year it was sold to the Fairchance Iron Company, by which its capacity, previously increased to ten tons, was further enlarged, so that the daily yield occasionally reached twenty tons. For some reason the property has lain idle for several years.

In 1802, General Arthur St. Clair built Hermitage furnace on Mill creek, at nearly two miles from Ligonier borough in Westmoreland county. It was very small, as is attested by its ruins, which are still to be seen alongside of the Johnstown pike near Ligonier. In part, it used a mountain ore belonging to the Brookville group, but it is said to have been dependent chiefly upon an ore belonging to the Lower Barren Series at about 150 feet below the *Pittsburg coal*

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bed. This furnace went out of blast in 1810, but was blown in again by General O'Hara in 1816, who, however, ran it for but a short time. The coal used in the blacksmith shop was packed in sacks from Lockport on the Conemaugh until 1807, when a violent flood, known as the "Pumpkin flood" exposed the blossom of the previously unknown *Pittsburg bed.* Thereafter the supply was obtained nearer home.

In 1809, Messrs. Johnston and McClurg erected Washington furnace, on the Bedford pike, near the crest of Laurel ridge in Westmoreland county, to work an ore of the Brookville group, which occurs quite abundantly in that neighborhood. The furnace was operated with some irregularity until 1856 or 1857, when it went out of blast finally. Probably about the same time Mr. McClurg built Mt. Pleasant furnace on Jacob's creek in Mt. Pleasant township of Westmoreland county. It was a small stone stack, with a capacity of less than two tons, and went out of blast in 1820, while under control of Mr. Freeman. The ore worked belongs in the Mahoning sandstone, and is equivalent to the Johnstown ore. The metal was hauled in wagons twenty miles to West Newton on the Youghiogheny, where it was transferred to flats and shipped to Pittsburg.

In 1810, Messrs. Trevor and Slater erected St. Johns furnace on Indian creek, at the east base of Chestnut ridge in Fayette county. Little is known respecting the operations at this furnace. At about the same time, Mr. Benninger built Hannah furnace on Tub-mill creek at the base of Laurel ridge in Westmoreland county, and soon afterwards built a forge at Bolivar on the Conemaugh. No information can be obtained respecting either the furnace or the forge.

In 1812, Robert Jones erected Springhill furnace on Rubbler's run, at the west base of Chestnut ridge, near the West Virginia line. It was somewhat larger than the other furnaces built at that time, as it had a capacity of two tons and a half. At first, it used the Blue Lump ore, which was hauled from Georges creek, a distance of four miles; but in 1833 the property passed into the hands of Mr. F. H. Oliphant, who thereafter used only ores from the Brookville and Umbral groups. This furnace remained in success-

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ful operation until 1870, when it was sold with Fairchance to the Fairchance Iron Company. Since that time it has been out of blast, and the property is fast going to decay.

In 1814, Mr. Meason built Ross furnace on Tub-mill creek in Westmoreland, not far from the site of Hannah furnace. A new stack was erected in 1842 by Paull, Meason and Matthiat, which was kept in blast until 1854 or 1855. The ores used at this furnace belonged to the Brookville group. Under Mr. Matthiat's management the concern was very prosperous; the iron was very good, and much of it was cast into stoves and pots, of which many are still in use.

In 1815, Mr. Isaac Meason with his sons, Isaac, Jr., and General Thomas Meason, built Dunbar furnace on Dunbar creek, near the present line of Wharton and Dunbar townships. This was afterwards known as Center furnace. It passed into the hands of Mr. George Meason, son of the General, by whom it was carried on until about 1830, when it went out of blast. Of the stone stack, only the ruins now remain, but the walls of the casting house are in excellent condition, and show that the structure was of the most substantial character. This furnace depended on ores belonging to the Umbral group.

In 1818, Finley Furnace, more commonly known as Breakneck furnace, was built on Breakneck run in Bullskin township of Fayette by Messrs. Miller, Rogers and Paull, but was managed by Miller, who kept it in blast until 1836. In the same year some persons from Pittsburg built Baldwin furnace on Laurel hill run at the base of Laurel ridge near the Conemaugh river. But respecting this furnace no information could be obtained.

In 1820, Ætna furnace was built on the bank of the Youghiogheny at about half a mile above Connellsville by Thomas and Joseph Gibson, who kept it in operation until 1836, when, in consequence of the financial disturbance, it was shut down. In the same year, or possibly a little earlier, Mr. McKane built Coolspring furnace on Shute's run in North Union township of Fayette county. The furnace was small and its blast was supplied by water-power. The ores used belonged to the Umbral group and were obtained

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by benching. The cost of reduction must have been insignificant to justify the extensive excavations made everywhere for miles along the outcrop of the Little Honeycomb ore-bed. In 1855, the furnace passed into the hands of Mr. F. H. Oliphant, who kept it in operation until 1860, when it was abandoned as the supply of water was uncertain.

During the next decade, belong several furnaces respecting which no information was obtained in detail. These are Fountain furnace on Camp run at the base of Laurel ridge in Donegal township of Westmoreland; Conemaugh furnace, built at the west end of the Conemaugh gap through Laurel ridge by General Foster White and J. McGill; and Lockport furnace, built at Lockport on the Conemaugh by Thomas and William McKennan. All of these furnaces have been out of blast for many years.

In 1827, Fayette furnace, at the base of Laurel ridge in Springfield township of Fayette county, was built by Rogers, Linton and Miller, by whom it was kept in blast until 1840 or 1841. The stack is a massive stone structure, lined with ordinary sandstone, and its capacity was from two to three tons per diem. The supply of ore was drawn chiefly from a bed of shale holding the place of the Upper Kittanning limestone or Johnstown cement bed. The metal was hauled in wagons to Connellsville on the Youghiogheny river, whence it was shipped on flats to Pittsburg. The metal was excellent for foundry purposes and much of it was cast into stoves and pots at the furnace.

In the same or in the following year, New Laurel furnace was built not far from the place of Old Laurel in Dunbar township of Fayette. The builders, James Paull and Sons, kept it in blast until 1834, when it passed into the hands of Mr. Daniel Kaine, under whose management it remained in blast until 1838. The iron was made from the Umbral ores and was shipped to Pittsburg on flats from the mouth of Laurel run.

After 1827, no new furnaces were erected until 1839, but, as appears from the notes respecting the several furnaces, the interval was a busy one, marked by vast improvements in the processes employed and upon the whole it was a

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profitable one until 1836. The great drawback to most of the furnaces then in operation was uncertainty of reaching market. Most of them had only river transportation, and this was available only at time of flood, which unfortunately is not a certain time. In numerous instances all advantage of a favorable turn in the market was lost, and, when the iron was delivered, the price had receded so as to be hardly sufficient to pay the cost of production, and the whole outlay for transportation was loss. In this way, the business became almost as uncertain as dealing in lottery tickets, unless the shipper had large capital and could afford to hold his metal. The financial crash of 1836 and 1837 crushed many of the weaker concerns, and several of the stronger ones voluntarily went out of blast soon after.

In 1839, the Hon. Andrew Stewart built Wharton furnace in Wharton township of Fayette county, at a little distance south from the National road. The stack was a stone structure, stone-lined, and had a capacity of three tons. It was managed by Mr. D. S. Stewart from 1839 until 1856. It was again blown in in 1858 and was kept in blast with varying success until 1873, since which time it has been idle. The iron was hauled to Brownsville on the Monongahela, where it was placed on flat-boats for shipment to Pittsburg. The uncertainty of reaching market and the expense of hauling the metal caused the final failure of the enterprise.

In 1846, a new venture was made in Westmoreland county to work the ores on Laurel ridge, and Messrs. Hale, Gallagher and Reed erected Laurel Hill furnace on a run of the same name, about a mile south from the Conemaugh river. The ores used here were obtained in part from the Umbral group and in part from the Lower Barren Measures. The stack was constructed of stone and lined with blocks of the Pottsville conglomerate. Its weekly yield averaged 33 tons, though sometimes it reached 40. This was one of the first furnaces to utilize the furnace gases for heating the blast, a process which had been introduced by F. H. Oliphant but a short time before this was erected. The iron produced here was in great part converted into castings on the premises. The furnace went out of blast in 1855, and soon after-

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wards the casting house and several other buildings were destroyed by fire.

In 1850, Mr. L. C. Hall built Hillsview furnace near the line between Ligonier and Fairfield townships of Westmoreland county. For this furnace, coal from openings in the *Pittsburg bed* was coked in ricks upon the ground, and it is said to have proved good. The supply of ore was obtained at 150 feet below the *Pittsburg coal bed.* The furnace was not successful and soon went out of blast.

In 1853, California furnace was built near the site of old Westmoreland by Messrs. Matthiat and Cummins, the former having previously dissolved his connection with Ross furnace. Owing to business complications into which his partners fell, Mr. Matthiat failed in this enterprise and the furnace was soon thrown out of blast. The ore-supply was obtained from the Brookville group.

In 1854, Colonel J. Clifford built Oak Grove furnace at the junction of Hanna's run with Mill creek, about three miles from Ligonier borough. This furnace used but little mountain ore and depended chiefly upon the bed 150 feet below the *Pittsburg coal.* It remained in blast for little more than three years.

To this decade probably belong Mt. Hope and Buena Vista furnaces, which stood at the east base of Chestnut ridge north from the Youghiogheny river; but it has been found impossible to obtain information respecting their place or the time of their erection.

No new furnaces have been built in Westmoreland county within the Ligonier valley since 1854, and indeed the iron ores of that whole valley have remained neglected since 1856, except in Wharton township of Fayette county, where spasmodic attempts to work them have been made at Wharton furnace. Since 1857 all attention has been turned to the ores on the west slope of Chestnut ridge within Fayette county and to those under the *Pittsburg coal bed* in the coke basin south from the Youghiogheny river. In this region the manufacture of iron has gone on continuously and within four years it has received a very considerable impetus. In 1857, four furnaces were in oper-

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ation along the base of Chestnut ridge, south from the Youghiogheny river,—Springhill, Fairchance, Redstone and Union.

Within a few years, all of the old charcoal furnaces have gone out of blast and in their stead there are now fine coke furnaces. The most southerly of these is new furnace erected by Mr. F. H. Oliphant, three miles south from Uniontown, which has a capacity of fifteen tons and depends exclusively on the Pittsburg ores. At three miles northeast from Uniontown is the successful Lemont furnace which has done so much to retrieve the reputation of the region. It is capable of making forty-five tons *per diem*. On the site of old Union furnace is the magnificent Dunbar furnace, which is perhaps the most complete plant in western Pennsylvania and has a capacity of eighty tons per diem. While furthest north on the border of Westmoreland county is Charlotte furnace, capable of making forty-five tons a day. All of these depend almost wholly upon the native ores, though they use a small proportion of foreign ores in their mixture. The remodeled Fairchance furnace is still out of blast, but, as railroad transportation will be afforded it within a year, it no doubt will soon be in blast again.

2. The earliest work done in the manufacture of iron was by John Hayden, who had a small bloomery, which, as already stated, was succeeded by Fairfield furnace. Here the first wrought iron was made, and it was certainly the first wrought iron made west from the Allegheny mountains.

In 1797, according to a statement quoted by Mr. Pearse, there were two forges in operation, both of them connected with Union furnace. Between 1809 and 1812, ten forges were set in operation of which all, but that near Youngstown on the Loyalhanna, were in Fayette county. Two of them were on Georges creek, two on Dunbar, one on Indian creek and the rest were scattered along the Youghiogheny river. The metal from the Georges creek forges, belonging to the Oliphant Brothers, bore for the time a very high reputation; but that from the other forges was known

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as "Redstone iron" and, for the most part, was thought to be of rather inferior quality. The Oliphant iron was tough and strong, excellent for ploughs and other implements exposed to rough usage.

To utilize the Redstone iron from his forges, Mr. Meason erected a rolling mill on Redstone creek, near the present village of Upper Middletown. The mill was finished in 1816, and there, in September, 1817, was made the first bar of iron ever rolled west from the Allegheny mountains. Mr. Meason also manufactured nails at this mill, using machinery in part in their manufacture, but the quality of the iron was poor, and the nails were unsatisfactory. The venture proved unsuccessful, and was soon abandoned.

In 1819, the Oliphant Brothers purchased a small forge on the Youghiogheny river, six miles below Connellsville, and placed it in charge of Mr. F. H. Oliphant, who is still engaged in manufacturing iron in Fayette county. At that time, two hundred bushels of coal and the labor of two men were needed to prepare one ton of wrought iron in a day, and the product was far from being of superior quality. Within five years, Mr. Oliphant succeeded in so reducing the cost of production, that, in a day, two men could prepare a ton of metal with an expenditure of only eighty bushels of coal, and the iron was vastly superior to that obtained by the old process. The pig metal, used at this forge, was hauled from Fairchance furnace, a distance of 18 miles.

In 1834, this forge was sold, and Mr. F. H. Oliphant, who had succeeded to the control of Fairchance furnace, erected a rolling mill in connection with that furnace. The mill had three puddling furnaces and complete machinery for the manufacture of bar and boiler iron. It remained in operation until 1870, when the property passed into the hands of the Fairchance Iron Company.

In 1825, Mr. F. H. Oliphant conceived that the furnace, gases might be utilized and, in that year, he advised a firm who were about to build a furnace in Alabama, that the boiler house should be placed on top of the stack. The experiment was tried and proved thoroughly successful, so

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that when, a few years later, it was necessary to reconstruct Springhill furnace, the boiler house was placed upon the top of the stack and the gases were fully utilized.

Up until 1836, no attempt had been made to use any fuel except charcoal, but in 1835 the Franklin Institute of Philadelphia had offered a prize for the first iron made with coke in this country. In the following year, Mr. Oliphant, being about to blow out his furnace for repairs, determined to make some coke-iron. He was fully successful, running for several weeks with coke and making iron of excellent quality. Samples of the metal were sent to the Franklin Institute and a notice of their receipt with a description of the process used was published in the journal of the society. To Mr. F. H. Oliphant, therefore, is due the credit of being the first to make coke-iron in America. Unfortunately the furnace was not constructed so as to use coke to the best advantage, and, as charcoal was still a very cheap fuel, Mr. Oliphant returned to the old method and did not use coke constantly until somewhat more than two years later, when he rebuilt the furnace.

In the same year, Mr. Oliphant introduced the warm blast at Fairchance furnace. Though the hot blast had been used before that in Europe, Mr. Oliphant claims, no doubt very justly, that the application was original with him. At Fairchance the air for the blast was driven through a pipe 150 feet long, leading from the rolling mill to the stack and, of this, about fifty feet were exposed. During some excessively cold weather, Mr. Oliphant noticed that the furnace was working badly and that chilling was occurring at the tuyeres. He directed that a fire be made under the exposed portion of the air-pipe, whereby the air was heated to such an extent that the trouble entirely disappeared, while the action of the furnace became unexpectedly rapid. The beneficial results of using a heated blast were so positive that, when the furnace was re-constructed, Mr. Oliphant added apparatus for producing a hot blast.

Until 1855, all the other furnaces in this region continued to use the cold blast, but in that year hot blast apparatus

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was added to Union furnace on Dunbar creek, and in the following year that furnace was changed so as to use coke. Hot blast apparatus was added to Wharton furnace in 1855, but it was not tested until 1856, just before the furnace went out of blast. The effect on the production of metal was very marked, as immediately upon application of the blast, the daily yield of Wharton furnace was increased from three tons to seven tons.

NOTE—For much of the information used in preparing this chapter I am indebted to Mr. F. H. Oliphant and Mr. Daniel Kaine of Uniontown, and Col. J. McFarland of Ligonier. A few notes have been taken from Mr. J. B. Pearse's "History of Iron Manufacture," which are duly acknowledged in the connection.

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Chapter XV.

The Iron Ores of the Ligonier Valley.

In this valley the Pittsburg ore group is unrepresented, there being no ore whatever within a distance of 25 feet below that coal bed.

In the Lower Barren Series there are a few streaks of ore, which seem to have a certain degree of persistence. The first of these is at 150 feet below the *Pittsburg coal bed* and within a few feet of the top of the Morgantown sandstone. This ore-bed occurs on Mill creek in Ligonier township of Westmoreland, and it was the source of supply for Hermitage, Oak Grove and Hillsview furnaces. The bed is no longer exposed at any locality and the extensive strippings have removed it so far from the original outcrop, that an exposure can be made only at much expense. The ore is said to be from one to three feet thick and to be in a solid bed. Samples were taken from the Oak Grove property, now belonging to Mr. Graham, and were sent to Mr. A. S. McCreath for analysis. The result is as follows:—

Iron,	28.800
Sulphur,	.156
Phosphorus,	1.765
Insoluble residue,	6.400

The ore carries some carbonate of lime, but the proportion of phosphorus is so great as to render the material almost utterly worthless. It is said to have been hauled to Washington furnace, to be used as a flux. The bed is persistent along Mill creek and its tributaries, and it can be traced easily by means of the Morgantown sandstone which it overlies.

The Black Fossiliferous limestone becomes an iron ore along the eastern edge of the valley, north from the Loyalhanna, and it has been mined at many places for use at the furnaces. In Fairfield township of Westmoreland it was mined near Hendrick's run for Laurel Hill furnace, but it seems that very little was removed, for the mining opera-

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tions had been hardly begun, when that furnace went out of blast. The same bed was mined to some extent in Ligonier township for use at old Washington furnace. The ore is evidently lean and poor at all the localities where it was examined; and the fact that it was used at all seems to imply that the furnaces were supplied only with difficulty and that the ore beds, on which dependence had been placed, had proved uncertain. For certainly the ore from the Black limestone is so poor that it would be used only as a last resort.

Within the Mahoning sandstone there is at some localities a calcareous ore which is equivalent to that at Johnstown. This is the same with the bed seen over the Mahoning at many localities along the west side of Chestnut ridge, and there seems to be no room for doubting that the upper division of the Mahoning sandstone is wanting on the west side of that ridge. At some localities in the northern portion of the valley no calcareous ore occurs at this horizon, but in its stead there is a dark ferruginous shale, which contains a notable percentage of iron. This was once digged for the Laurel Hill furnace and it is said to have been mined largely on Tub-mill run for use at Ross furnace. Along the base of Laurel ridge it is always lean and is unaccompanied by limestone.

But on the west side of the valley and at some localities near the Youghiogheny river toward the center of the trough, it is a calcareous ore. It is the Stewart ore near Meadow run, the ore worked at the Springfield mines on the Youghiogheny, that on the Weaver property north from Falls city, and that exposed on the clay pike in Mount Pleasant township of Westmoreland. At all of these localities the ore is good and quite rich in iron. It was mined and reduced at Mount Pleasant furnace on Jacob's creek and for some time it was mined near the Youghiogheny below the mouth of Indian creek. It seems to be present at a majority of exposures of its place within the elevated region south from the Youghiogheny and near the central line of the trough. The following analysis by Mr. McCreath of a sample from Mt. Pleasant township shows the character of the ore:—

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Iron,	34.700
Sulphur,	.174
Phosphorus,	.104
Insoluble residue,	13.750

The Freeport ore group is poorly represented within the Ligonier Valley, though there its ores are perhaps more important than they are on the west side of Chestnut ridge.

The Freeport limestone is occasionally quite ferruginous on the outcrop, where it has long been exposed to the air. At Laurel Hill furnace in Westmoreland county it is quite as ferruginous at the outcrop as it is near Springhill furnace in Fayette county and it was mined by benching to supply the furnace; but it yielded a badly cold-short metal. In Wharton township of Fayette county this limestone is often so ferruginous near the crop that it has been mistaken in more than one instance for an ore bed. Even in its best condition this is valueless as an ore.

A deposit of some importance occurs in many places at the horizon of the Johnstown cement bed, or Upper Kittanning limestone. The limestone is irregular in its occurrence, being frequently replaced by a shale carrying great quantities of nodular iron ore. This ore has been mined at several localities in Westmoreland county where it was thought to be quite important. But the quantity is really insignificant at most exposures and, upon the whole, the deposit may be regarded as practically worthless. It was seen on Hendrick's, Laurel, Furnace, Linn and Powder Mill runs within Fairfield, Ligonier and Cook townships of Westmoreland, as well as on Furnace run in Springfield township of Fayette. At all of these localities the ore is nodular, the nodules not too closely packed together and by no means over-rich. The ore was mined usually by benching, but on Laurel run of Ligonier township it was drifted for after the cover become too deep to admit of benching. The following results were obtained by Mr. McCreath by analysis of a sample from Fayette furnace property in Springfield township of Fayette county:

Iron,	33.900
Sulphur,	.333

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Phosphorus,	.302
Insoluble residue,	18.690

Occasionally an iron ore occurs within a short distance below the *Lower Kittanning coal bed* but for the most part it is without value. On Furnace creek in Springfield township of Fayette, it seems to have been of some importance for it was benched extensively to supply the furnace there. A sample analyzed by Mr. McCreath showed:

Iron,	38.100
Sulphur,	.159
Phosphorus,	.115
Insoluble residue,	9.250

So that it is very far from being an inferior ore in point of quality, and it is fully equal to the ores of the Umbral series.

The Brookville Ore Group, the same with that, which in Report KK was called the Mount Savage (?) Ore Group, is represented by a single ore bed along the base of Laurel ridge in Ligonier and Cook townships of Westmoreland county. No evidence of its existence could be discovered along the face of Chestnut ridge within that county, and there seems to be every reason to suppose the group altogether absent from the southern portion of the valley.

The bed as found in Ligonier and Cook townships was undoubtedly of much importance, and the ore, known locally as the "blue ore," was benched extensively for use at Westmoreland, California, and Washington furnaces. It may have been used also at Hermitage, but of this nothing is certainly known. Unfortunately the benching was so extensive that now one is unable to determine either the thickness or the exact position of the bed. It is apparently not more than 25 feet above the Pottsville conglomerate and is, therefore, in the same horizon with the "Jude" ore of southern Fayette county on the west slope of Chestnut ridge. The ore shows very little variation and its quality is shown by the following analysis of a specimen obtained on the Bedford pike near old Washington furnace (A S. McCreath):

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Iron,	32.500
Sulphur,	1.288
Phosphorus,	.152
Insoluble residue,	15.130

The iron made from this ore was of excellent quality and, except that made at Westmoreland, always had a high reputation.

The Umbral Ore Group has by no means the same importance within the Ligonier Valley that it possesses on the west slope of Chestnut ridge within Fayette county. In Westmoreland it is absent from Chestnut ridge and is poorly represented by but a single bed on Laurel ridge near the Conemaugh river. Possibly other beds may be present on Laurel ridge, for the explorations made at Laurel Hill furnace were too limited to set the matter beyond doubt.

Southward from Tub-mill run along the eastern side of the valley there are no traces of the group, and where the Youghiogheny crosses the synclinal no ore occurs at this horizon aside from a few scattered lumps; a similar condition seems to prevail on the western side of the valley and north from the Youghiogheny river in Fayette county, for along that river the exposures are perfect for several miles and there are no regular ore-beds within 100 feet below the Pottsville conglomerate. Occasionally nodules occur in numbers, but they are seldom collected into layers and they as seldom occur in quantity to be of economic importance. It may therefore be taken for granted, that to all intents and purposes the Umbral Series of ore-beds is absent from the Ligonier Valley north from the Youghiogheny river.*

Whether or not the group is fairly represented along Laurel ridge south from the Youghiogheny river cannot be determined from the exposures with any degree of cer-

* Near the summit of Laurel Hill, on the Somerset side of the line, a solid plate of Umbral ore, about a foot thick, forms the surface, covered only with a thin layer of forest mould, over an extent of several acres. The locality was passed in moving camp in 1840, and must have been somewhere south of the Mud Pike. No exposure of the ore on the Westmoreland side of Laurel Hill was seen by us at that time.—J. P. L.

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tainty. On the west slope of that ridge in Henry Clay township of Fayette county, some nodular ore was seen, about three miles south from the National road, associated with a double coal bed, which belongs at a short distance below the Pottsville conglomerate. But aside from this no other evidence of the ore-beds was found, though much more is said to occur near the head of Tub-mill run in the same township and on the east side of the axis.

But on the east slope of Chestnut ridge south from the Youghiogheny, the ores come in in large quantity and the number of the beds is greater than that on the west side of the same ridge. Thus on the Wharton furnace property there are not less than nine beds varying from 4 inches to somewhat more than 1 foot in thickness and they all, with one exception, yield good ore. At a little distance north from the National road are the benchings made for Mr. F. H. Oliphant at the time he was operating Coolspring furnace. These have effectually masked the exposures, and it is not possible now to ascertain the number of the beds, though the benchings show that there are not less than five, which were digged to a greater or less extent.

The Laurel furnaces in Dunbar township obtained their ores from beds of this group, but the exposures near those furnaces are so bad, owing to the former extensive benchings, that nothing can be ascertained respecting either the number of the beds or the character of the ores.

On a branch of Dunbar entering that creek at old Center furnace, the exposure is very good for 75 feet below the Pottsville conglomerate, so that both the Big and the Little Honeycomb are well shown. In the same neighborhood, but on the highland, back of the old furnace, there is a peculiar ore, which was benched extensively to supply the furnace. It is but a short distance below the Pottsville conglomerate and seems to be not far from the place of the Little Honeycomb bed. Samples of these ores were sent to Mr. McCreath for analysis. The results are:

I. Big Honeycomb ore, Center furnace.

II. Little Honeycomb ore, Center furnace.

III. Little Honeycomb ore??, Center furnace.

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	I	II	III
Iron,	42.300	42.500	42.500
Sulphur,	.227	.153	.484
Phosphorus,	.128	.130	.160
Insoluble matter,	9.640	7.110	5.190

It is quite clear that these ores are but little if at all inferior to ores from the same beds on the opposite side of the ridge.

The ores near Wharton furnace seem to be present in great quantity and to be of excellent quality, but owing to the dilapidated condition of all the drifts and benchings it was found impossible to inspect the beds or to procure specimens for analysis. It is sufficient, however, that from these ores iron of excellent quality was made during many years and that the cost of manufacture was moderate. All the profits were absorbed by the cost of shipping the metal to market, as the nearest outlet was at Brownsville on the Monongahela, 20 miles away, to which point the iron had to be hauled in wagons.

For the most part the ores of this whole region are carbonates though in nearly every case there is a shell of oxide near the outcrop. But the Little Flag at Wharton and the Umbral ore at Laurel Hill furnace seem to be hematite throughout. The latter bed was mined by drifts, which had been opened through the conglomerate, and under this heavy cover the ore is still hematite for a distance of several hundred feet. The same condition appears in the long drifts upon the Little Flag at Wharton.

Respecting the value of the ores in the Ligonier Valley but little remains to be said.

North from the Youghiogheny river the ores are too insignificant to justify the erection of furnaces. This is especially the case in Westmoreland county, where even the small charcoal furnaces built fifty years ago were soon in straits, as appears not only from the extended search made for ore, but also from the wretched quality of some of the ores which were used. At some localities south from the Youghiogheny along the east slope of Chestnut ridge,

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the ores are sufficient to supply a furnace of moderate size as may be seen near Old Laurel and Old Center, as well as at the old benches made by Mr. Oliphant for Coolspring and at the extensive dvelopments for Wharton furnace.

There is little reason to believe that the Westmoreland ores, even those along the most favored lines of transportation, can ever be mined and shipped to other places for reduction. The ore-bearing shale at the horizon of the Johnstown cement bed is uncertain, liable to be replaced at any time by the limestone, while at the best the ore occurs only in nodules scattered through a great mass of shale; so that, were the iron trade in even so good condition as it was before 1873, there is room for doubting whether the ore could be sold at a price which would repay the cost of mining and transportation. The only other ore within this region, which is good enough for the manufacture of iron, is that representing the Brookville Group, which was used at the furnaces near the Bedford pike in Ligonier township. Even in this bed the nodules are so scattered that digging them would be costly.

It is commonly supposed that because these deposits supported so many furnaces in former times therefore they are good now. But the manufacture of iron has been revolutionized within the last twenty years, especially by the introduction of coke as a fuel. Now a furnace requires not six or nine tons of carbonate ore each day, but at least 120 tons in order that, under the circumstances, the manufacture may be carried on with profit. It stands to reason, therefore, that, if the little two-ton furnaces had difficulty in obtaining a full supply of ore, a forty ton furnace would find existence impossible, unless the whole population would become ore-diggers to keep it in operation.

The difficulty in Fayette county south from the Youghiogheny is different. There, ore is good and plenty, but fuel and outlets to market are wanting. There is no coal suitable for making coke; and under present conditions, which are likely to be the present conditions for a number of years, charcoal iron cannot be made with profit from iron containing considerable quantity of phosphorus. Lack of trans-

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portation seems to render almost impossible the shipment of the ore to more favored localities. The long tramway from Lemont furnace to its mountain mines on the west side of Chestnut ridge reaches to within a comparatively short distance from the ores near Center furnace, so that a tramway could be made to transport the Center ores to Lemont furnace, just as the ores from the Oliphant benchings north from the National road could be carried down Shute's run to the same furnace. But in this way only an insignificant amount could be disposed of.

It seems evident then that, for the present at least, the ores of the Ligonier Valley are not likely to be utilized; those of Westmoreland county, because the quantity is insignificant, and those of Fayette county, because to all intents and purposes they are inaccessible.

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Chapter XVI.

The Iron Interest on the West Slope of Chestnut Ridge.

While, in all probability, many years must elapse before the ores of the Ligonier Valley can assume any economical importance, the case is far different with the ores along the west slope of Chestnut ridge, especially with those in the region south from the Youghiogheny river. The mountain ores, described in Report KK, are known to be persistent along the whole face of the ridge from Jacob's creek southward to beyond the State line, while the even more important group immediately underlying the *Pittsburg coal bed* has been proved up along the whole eastern outcrop of that coal bed south from the Youghiogheny river, as well as across the Saltsburg axis into the southern portion of the Lisbon trough.

Four furnaces are now in blast within this area, all of which have been erected since 1872.

Charlotte furnace, erected in 1873, stands on Jacob's creek within Westmoreland county, near the intersection of the Mount Pleasant branch of the Pittsburg and Connellsville Road with the Southwest Penn Railroad. The stack is 65 feet high, and consists of an iron jacket lined with firebrick; the measurements being, at hearth, 6 feet, boshes, 16 feet, at tunnel-head, 8 feet. It is provided with six tuyeres, 4½ by 7 inches. The temperature of blast is about 700 degrees, and the pressure used is 5 pounds. The average weekly product of metal during 1877 was 294 tons.

Dunbar furnace is on Dunbar creek, about three miles from Connellsville, and stands very near the site of old Union furnace. The present furnace was begun in 1876, and went into blast in 1877. The stack is 77 feet high, and consists of an iron jacket lined with Mount Savage and Ohio river brick; the measurements are, at hearth, 8 feet, at boshes, 20 feet, and at tunnel-head, 9 feet 6 inches. It is provided with seven five-inch tuyeres, and the blast is heated by three Whitwell stoves. The temperature of the

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blast varies from 850 to 900 degrees, and the pressure used is from 4 to 6 pounds. The whole plant is admirably complete, and the average weekly product, while in operation, has been somewhat more than 450 tons.

Lemont furnace, on a branch of Shute's run, about three miles northeast from Uniontown, was erected in 1875 and blown in early in 1876. The stack is an iron jacket lined with fire-brick, obtained in part from Mount Savage and in part by manufacture from the excellent fire-clay found on the company's property. The stack is 65 feet 6 inches high, with diameter at hearth, 6 feet, at boshes 15 feet 6 inches and at tunnel-head, 12 feet. It is provided with six five-inch tuyeres, the temperature of the blast is 800 degrees and the pressure is 4 pounds. The furnace is capable of making 300 tons per week but the average product during the latter half of 1877 was only 250 tons.

Mr. Oliphant's new furnace is on Georges creek, about three miles southeast from Uniontown. It was erected in 1876 and went into blast near the close of that year. The stack is 50 feet high, constructed of brick, banded with iron and has a lining of firestone, 18 inches thick. The temperature of the blast is 500 degrees and the average pressure is 2½ pounds. During 1877, the average weekly product was about 80 tons.

In addition to these is Fairchance furnace on Georges creek, about six miles south from Uniontown. It is not in blast and I could not obtain its statistics. The stack is about 50 feet high and 10 or 12 feet diameter at the boshes. Originally it was lower and naked, but, after passing into the hands of the Fairchance Iron Company in 1870, it was raised and inclosed in an iron jacket. It will probably be put into blast within a year, as the Southwest Railroad will reach it before the close of 1878.

The production of these furnaces has been below their capacity during 1877, owing to the extremely depressed condition of the market.

Of these furnaces, Charlotte uses of native ore only that obtained from the Mountain, Dunbar and Lemont use ores

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from the Umbral and Pittsburg groups, while the Oliphant furnace depends altogether on the Pittsburg group.

Character and Extent of these Ores.

The important ore groups in this region are the Umbral and the Pittsburg. The others of those described in Report KK are so variable in distribution and character that they may be omitted altogether from this summary as being without material economic value.

The Umbral Group. This contains four persistent ore beds. The highest, known as the Little Honeycomb, occurs at about 20 feet below the Pottsville conglomerate and is seldom more than four inches thick, so that it is available only when the cover is thin enough to admit of stripping.

The Big Honeycomb is usually a compact flag, 10 to 12 inches thick, and at most localities shows little tendency to variation. It is persistent to a considerable distance north from the Youghiogheny river, but seems to disappear before reaching the northern limit of Fayette county. The ore is fine-grained, smooth and has always been regarded as of excellent quality. Analyses by Mr. A. S. McCreath, as well as by other chemists, show that the percentage of metallic iron varies from 35 to 41, that of phosphorus from 0.03 to 0.22, and that of sulphur varies little from 0.15.

The Kidney ore is persistent from Jacob's creek to the State line. It is usually a plate ore from 4 to 8 inches thick and is easily mined, as a small coal bed below it affords a good bearing-in for the digger. Analyses of this ore by Mr. McCreath and others show that the iron varies from 31 to 41 per cent., the phosphorus from 0.10 to 0.19, and the sulphur from 0.08 to 0.40. The bed is regular in most localities.

The Big Bottom is constantly present at all localities from Jacob's creek to the State line, and occurs in flags, with a total thickness varying from 10 inches to 3 feet. The percentage of iron varies from 32 to 37, of phosphorus from a mere trace to 0.25. Selected specimens have shown 41 per cent. of metallic iron. This bed is usually either

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double or triple. Unlike the other beds, it is much injured by "wants" or horsebacks, as mentioned in Report KK, but these are not thought to detract materially from the value of the deposit, for in front of each want, as well as behind it, the ore increases to far beyond the average thickness. It is thought to be a most important bed and has been thoroughly prospected at Dunbar and Lemont mines as well as at those belonging to the Charlotte furnace.

The Pittsburg Group. For all practical purposes this may be regarded as including only the ores occurring immediately below the *Pittsburg coal bed.* Its variations are such that no brief description would be satisfactory and the reader is referred for details to Report KK, pp. 111 to 119. The change in this group seems to take place at a short distance north from the National road, the ores north from that line being somewhat inferior to those south from it. The whole group evidently disappears northward before reaching the Youghiogheny river, but it is persistent southward to beyond the State line. It crosses the Saltsburg axis in Springhill township of Fayette county and is present at New Geneva on the Monongahela river, as well as along the river certainly as far as the mouth of Cat's run, the northern boundary of Nicholson township. Beyond this line, its existence is doubtful, for on Brown's run in German township it seems to be wholly wanting, there being at its horizon only fireclay scantily stained with ferruginous matter.

In the southern portion of the Blairsville trough, the group contains four beds, known as the Blue Lump, the Big Bottom, the Red Flag and the Yellow Flag, the whole having a thickness of not less than 2 feet, and included within a vertical distance of not more than 12 feet. In the Blue Lump the iron varies from 39 to 42 per cent., the phosphorus from 0.07 to 0.08, and the sulphur from 0.01 to 0.04. In the Big Bottom the iron is 35 and the phosphorous only 0.04, while in the other beds the percentage of iron is nearly the same as in the last, though the percentage of phosphorous is slightly greater.

Northward from the National road the ore changes and

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at most localities, there is worked only a single or double layer varying in all from 15 to 22 inches. This is easily accessible and the ore, though varying in quality at different localities, is good. The analyses by Mr. McCreath show it to contain from 30 to 33 per cent. of iron and from 0.13 to 0.20 of phosphorous.

From what has been said, it can be seen that the ores of these groups, unlike those usually found in the Carboniferous series, are thoroughly persistent and can be depended on as a permanent source of supply. They have been thoroughly tried at the Lemont and Dunbar mines and it has been proved that they are capable of affording a supply far in excess of any possible demand.

Nothing short of an accurate topographical survey will give data on which to base a calculation of the amount of ore available in the Mountain beds. The many gorges cutting deeply into the mountain side have removed enormous areas of ores, though the erosion has not been without its advantages to the iron-master, as it has rendered what remains accessible. It is clear that the available amount is enormous, for the beds have a total average thickness of not far from 2 feet. At Dunbar, the mining has been carried on for nearly 80 years, and some drifts in the Big Bottom are more than 2000 feet long, while there are several drifts of half that length in other beds. At Lemont mines, the ores have been followed for more than 1000 feet without showing any sign of change in thickness or character, the Big Bottom always excepted, for that has shown its characteristic wants at Lemont and Vernon mines as well as at Dunbar.

The amount of ore present and easily available in the Mountain beds is certainly greater than that in the Pittsburg Group, and by increased preliminary expense, such as sinking shafts, the amount might be increased indefinitely; for the beds, without doubt, are distinct strata, essentially a portion of the column.

One may more readily ascertain the amount of ore in the beds of the Pittsburg Group, for these occur in the valley and, owing to the rapid dip, have suffered comparatively

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little from erosion. We may regard this group as fully proved for one mile beyond the outcrop along the east face of the Blairsville trough, there having extensive developments since the writing of Report KK. The area underlaid by the ore, as actually proved up, is nearly three times that given, and the average thickness of the bed is one half more than was stated in Report KK; so that not less than 200,000,000 of tons of ore are practically in sight and easily reached.

Details Respecting Mines Now in Operation.

Since Report KK, that for 1876, was rendered, some new mines have been opened and some of the old ones not then in operation have been re-opened. It may be well to make a passing reference to the present condition of mining operations.

At Mr. Oliphant's new furnace, a shaft has been sunk, draining a considerable area so that the ore can be obtained now by drifting. The increased cost of stripping, which was continued too long before the shaft was sunk, added materially to the cost of making iron at this furnace during the greater part of 1877.

At Lemont the operations have been extensive during the year. The coal-ore mines show 22 inches of handsome ore in the breast at the end of the longest drift, in quality fully equal to any that had been obtained at any time. This ore is in three layers. Specimens from these yield the following results on analysis (A. S. McCreath):

	I.	II.	III.
Metallic iron,	31.000	37.500	38.150
Metallic Manganese,	1.030	.691	.691
Sulphur,	.932	.512	.342
Phosphorus,	.151	.123	.121
Lime,	4.680	3.530	3.890
Magnesia,	5.405	3.459	2.828
Silica,	8.855	4.735	3.360
Iron in roasted ore,	47.880	56.020	57.220

These analyses are given here, since by an error in labeling, the samples forwarded last year were analyzed as one.

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With those, was accidentally inclosed a sample of an impure silicious layer which is always rejected. This being analyzed with the others gave a false character to the ore.

In the mountain mines the work has been pushed forward vigorously. The Big Bottom ore bed, which at the date of the last report had just been opened, has proved to be as subject to horsebacks as it is at Dunbar, though the wants thus far have not been extensive. The bed, however, is thick and yields an excellent ore, which amply compensates for any lack of regularity in its occurrence.

This company has tested some ores belonging to the Brookville (Mt. Savage) Group, but these are far from being satisfactory. One of them, of which a considerable quantity had been accumulated, is mottled and contains a very large proportion of clay and silicious matter, which is sufficiently apparent to the eye. One cannot refrain from expressing some surprise that such stuff should be thrown into a furnace, when excellent ores are present in quantity on the furnace property and can be obtained at a very low price.

At Frost's station, just north from Lemont, the coal ore is digged for shipment to Dunbar furnace, which has blown in since the date of my last report. The conditions here are as stated in report KK.

At Braddock's Station, Messrs. Hoggsett, Watt & Co., who have been engaged for a long time in the manufacture of coke, have made a careful examination of the coal-ore underlying their property, having in view the erection of a furnace. Pits were sunk at several places and the ore was found in three layers, from 20 inches to nearly 3 feet thick in all. The quality of this ore is shown by the following analyses of samples obtained at 1,100 feet from the outcrop. (A. S. McCreath :)

	I.	II.	III.
Metallic Iron,	29.000	33.900	28.800
Sulphur,	.603	.473	.492
Phosphorus,	.208	.112	.135
Carbonate of lime,	14.875	11.803	18.035
Carbonate of magnesia,	6.485	4.691	4.601
Insoluble residue,	9.540	5.540	10.030

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At the Dunbar mines the conditions show no material difference, but the mining has been carried on energetically during the year. The Coal-ore is very much better at the end of the drifts than it promised to be one year ago, and the quality now is fully equal to that of any ore previously obtained from this bed. The extensive mines in the Mountain ores, as described in Report KK, exhibit sufficiently the persistence of the beds.

No further developments have been made along the face of the ridge north from the Youghiogheny river.

Comparison with Ores of Other Regions.

It may be interesting to compare the carbonate ores of this region with those obtained elsewhere. The comparison is made on the opposite page where the following analyses are given:

I. Average of analyses of Big Bottom from this region. (A. S. McCreath.)

II. Average of analyses of Pittsburg ores. (A. S. McCreath.)

III. Average of Kidney and Honey Comb ores. (A. S. McCreath.)

IV. Hope furnace, Vinton county, O. (Wormley.)

V. Buckeye furnace, Jackson county, O. Average of two. (Wormley.)

VI. Star furnace, Jackson county, O. Average of two. (Wormley.)

VII. Black band, Tuscarawas county, Ohio. (Wormley.)

VIII. Johnstown, Cambria county, Penn. (Morell.)

IX. Ore from South Wales. (Percy.)

X. Same locality.

XI and XII. Cleveland district, England. (Cited by Potter.)

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Analyses of Raw Carbonate Ores.

	1	2	3	4	5	6	7	8	9	10	11	12
Metallic iron, ...	34.508	35.141	37.982	37.180	31.340	41.480	25.630	35.930	34.720	40.120	31.420	29.090
Sulphur, ...	0.153	0.336	0.215	0.100	1.720	0.470	0.310	0.850				
Phosphorus, ...	0.108	0.102	0.136	0.048	0.310	0.065	0.240	0.231	0.183	0.323	0.467	0.493
Insoluble residue, ...	17.152	10.296	13.059	18.170	20.200	9.500	30.320	4.885	13.010	10.330	10.360	10.040

Analyses of Roasted Carbonate Ores.

	1	2	3	4	5
Metalic iron, ...	54.800	54.350	40.810	44.500	62.760
Sulphur, ...	1.652	0.210	0.180	0.348	
Phosphorus, ...	0.171	0.424	0.694	0.432	0.414
Insoluble residue, ...	7.920	7.340	14.080	11.400	6.800

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I have thought it well also to compare the roasted ore of the Pittsburg Group with roasted carbonates elsewhere, and also with the Magnetic ores of northern New Jersey. These analyses make up the second table on the opposite page. They are as follows:

I. Roasted ore from Lemont. (A. S. McCreath.)

II. Roasted ore from Johnstown, Pa. (Morell.)

III and IV. Roasted ores from Cleveland district, England. (Cited by Potter.)

V. Magnetic ores from Ringwood mines, northern New Jersey. Average of nine.

From these analyses, it is evident that the carbonates of the Chestnut ridge region are but little inferior to those from the choicest localities in Ohio, and that they are certainly superior in respect of phosphorus to those of most other localities where such ores are used for the manufacture of iron. Other analyses of the roasted Pittsburg ore show that it holds a considerably higher percentage of metallic iron than is given in the table, and that in this respect it is but little inferior to the celebrated Ringwood ores of New Jersey, while in respect of phosphorus it is decidedly superior to them.

But the ores of the Fayette county region are much inferior to those of Lake Superior and Iron Mountain, in Missouri, for even the Pittsburg ores south from Shute's run have more phosphorus than the Lake and Missouri ores which contain a half more of metallic iron.

Character of Iron Produced.

In order to improve the quality of the iron made from the Fayette county ores, it has always been thought necessary to add some Lake or other slightly red-short ore. That by this process the metal could be improved there can be no doubt, but, since 1873, motives of economy led the iron-masters to use much mill-cinder, which containing more than a half per cent. of phosphorus and barely fifty per cent. of metallic iron, could hardly be looked on as a good "neutralizer" of phosphorus. It has been customary to add 8 or 10 per cent. of Lake ore to the mixture. The

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advantage of adding this proportion of foreign ore is not apparent, for it is too small to be of service as a diluent of the phosphorus and certainly the minute quantity of sulphur thus thrown in would not suffice to affect the phosphorus materially, if indeed the two elements act at all on each other. The more so when a much larger proportion of cinder was thrown in as an additional corrective.

Experience has shown that the mixture of a small proportion of foreign ore in no way increases the toughness of the pig, so that now most of the furnaces depend almost wholly upon the native ores. The effect of the mill-cinder upon the iron has been disastrous and unfortunately the material was used up until the close of the last season, so that the specimens sent in for analysis from Dunbar and Lemont were made from mixtures containing it. The metal from Mr. Oliphant's furnace was made from native ores alone.

The iron made by Mr. F. H. Oliphant at Fairchance and the other furnaces under his control during a period of more than fifty years, had a remarkably high reputation. For the most part this was produced from ores underlying the *Pittsburg coal bed*, the same which he uses at his new furnace and at the same horizon with the ore on which Lemont and Dunbar furnaces depend so largely. With this, Mr. Oliphant mixed more or less of the mountain ores, after the stripping had become so extensive that he could procure ore from the mountain as cheaply as from Pittsburg beds in the immediate vicinity of his furnace.

This metal was wholly neutral, was characterized by great tenacity and toughness, while the pig had a fluidity far surpassing that shown by iron made from Lake ore. In 1835 he sent to the Washington Navy Yard, five hundred pounds of cable made from one and one half inch iron, which proved to be two and one fourth times stronger than the standard. The links stretched 18 inches before breaking, while the iron bent as well hot as cold and *vice versa*. Much of this iron was sent to the National Armory at Harper's Ferry, where, being obtainable only in small quantities, it was used chiefly in the finer portions of the muskets.

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The Oliphant iron, as distinguished from the Redstone, early attained celebrity, and it was employed by Mr. Ross Winans in constructing those portions of the first locomotives which were to be subjected to great strain. While the National road was the great thoroughfare between the east and the west, Mr. Stockton, proprietor of the mail coaches, moved his shops to Uniontown that he might obtain the Oliphant iron, which he thought the best in the world for enduring rough usage. Mr. Oliphant subjected the metal to a severe test, for as soon as the patent on chilled rolls expired, he made a pair from his own iron, which were used constantly for fourteen years, and they were still in good condition when the furnace and rolling mill were sold in 1870.

The mixture now employed at Mr. Oliphant's new furnace is equal quantities of Blue lump and Pittsburg Big Bottom. The charge is:

Roasted ore,	600 lbs,
Coke,	11 bushels.
Limestone,	260 lbs.

Two samples of pig made in this way were subjected to analysis by Mr. A. S. McCreath with the following results, No. 1 being a mill-iron and No. 2, foundry:

	I.	II.
Carbon, graphitic,	3.040	2.330
Carbon, combined,	.100	.110
Silicon,	3.362	3.551
Sulphur,	.216	.256
Phosphorus,	.608	.996
Manganese,	1.195	.432
Copper,	.014	.018
Cobalt,	.051	.036
Iron,	91.414	92.271
	100.000	100.000

A rod made of the mill-iron, the same with that of which an analysis is here given, was sent in the autumn of 1877 to Altoona, to be tested at the shops of the Pennsylvania Railroad Company. The letter reporting on the test states that the rod bore a pressure of 21,900 pounds per square inch before

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yielding, which is above the average strength of the car-wheel mixture, and is stronger than any single iron used at those shops, while the strength is greater than that of most cold-blast charcoal irons. The grain is close and the iron works smoothly. It was thought that, if this iron would chill, it would be most admirable for use in manufacture of car wheels. No test has yet been made to ascertain whether it will chill well, but as already stated, the experiment made with the Fairchance iron, more than twenty years ago, was perfectly successful.

At Lemont furnace much mill-cinder has been used and that material formed a staple part of the mixture up until the furnace was blown out in November of 1877 for relining. The charge at this furnace is

Ore,	1,400 lbs.
Coke,	1,000 lbs.
Limestone,	1,050 lbs.

Several mixtures have been used, in order to ascertain if possible the best proportions. Two analyses were made of a foundry iron obtained by using the following mixture:

Pittsburg coal ore,	Nine fourteenths.
Mountain ore,	Two fourteenths.
Mill cinder,	Three fourteenths.

And one analysis was made of mill iron obtained by using equal parts of coal ore, mountain ore and mill cinder. The following are the results of the analyses (A. S. McCreath), No. 1 being average of the foundry and No. 2 the mill:

	I.	II.
Carbon, graphitic,	2.795	3.080
Carbon, combined,	.172	.125
Silicon,	3.009	2.531
Sulphur,	.099	.180
Phosphorus,	.928	.477
Manganese,	1.037	.231
Copper,	.091	.033
Cobalt,	.073	.037
Iron,	91.796	93.306
	100.000	100.000

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As the amount of phosphorus in the two irons shows so remarkable a difference, one which cannot be explained by reference to the analyses of the ores which have been made, I wrote to the firm owning the furnace making inquiry respecting the ores used in the foundry iron. They inform me that by an oversight there had been sent samples of iron made from a mixture containing some refuse "Big Bottom" ore, which, unfortunately, had been sent down to the stock-house and of which much had been thrown into the furnace before it was discovered. The villainous character of certain portions of the Big Bottom ore bed was sufficiently set forth in Report KK. On one occasion an error similar to that of Lemont almost ruined the reputation of Dunbar furnace.

The mill-iron is very good, and compares very favorably with other irons which are found in the Pittsburg market.

At Dunbar furnace the metal is made almost wholly from native ores, and the proportion of the coal ore used is large. The charge at this furnace is:

Ores,	900 lbs.
Coke,	600 lbs.
Limestone,	600 lbs.

All ores are roasted before they are put into the furnace. Analyses of mill and foundry iron by Mr. A. S. McCreath, yield as follows, the order being as given:

	I.	II.
Carbon, graphitic,	2.745	2.970
Carbon, combined,	.560	.110
Silicon,	1.373	3.114
Sulphur,	.125	.101
Phosphorus,	1.229	.999
Manganese,	1.160	1.037
Copper,	.011	.130
Cobalt,	.124	.081
Iron,	92.673	91.458

The iron from all these furnaces finds ready sale at Pittsburg, and it certainly is not thought to be by any means so cold-short as the analyses would show it to be. The proportion of uncombined carbon is very large, so that the irons

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are very good for foundry purposes. As foundry irons their reputation is very high.

For comparison I give here three analyses of the celebrated Cleveland pig irons of Great Britain, which "are used very largely for the production of rails and plates for ship building; amounting, in the case of the former, to about 750,000 tons, and in the latter, to nearly three fourths of that supplied in the kingdom." The analyses are those given by Prof. W. B. Potter, in the Second Ann. Rep. on the Geol. of Ohio,* whose language I have just quoted:

Analyses of Cleveland Pig Irons.

	I.	II.	III.
Iron,	93.59	93.73	93.71
Carbon, graphitic,	3.35	3.44	3.31
Sulphur,	0.04	0.03	0.03
Phosphorus,	1.38	1.24	1.36
Manganese,	0.07	0.43	0.06
Silicon,	1.57	1.13	1.43

Cost of Making Iron.

All my inquiries respecting the cost of making iron in this region have been answered with the utmost courtesy, and, in some instances, firms have not hesitated to show me their quarterly balances, which exhibit every detail of cost. As Lemont furnace has been in almost uninterrupted blast since the spring of 1876, and therefore has overcome the difficulties that are apt to beset a furnace during the early days of its first campaign, the figures seen on the books of that concern have been chosen as a basis in the estimate of cost of production.

Taking the mixture employed in making the mill-iron, which was analyzed from Lemont furnace, we find it with the fuel and flux to be as follows:

Pittsburg coal ore,	one third.
Mountain ore,	one third.
Mill-cinder,	one third.
Limestone, per ton of metal,	4,200 lbs.
Coke, per ton of metal,	100 bushels.

* Second Annual Report on the Geology of Ohio, 1871, p. 524.

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It is easy to ascertain the cost of the materials employed, as the terms of contracts with miners are not secret, and the cost of labor and repairs is shown on the company's books. As, however, I hardly care to state matters so purely private as the last two items, those are given in excess in the following calculation. The calculation is as follows:

2,000 lbs. of coal ore,	$1 30
1,325 lbs. of mill-cinder,	2 00
1,660 lbs. of mountain ore,	2 50
4,000 lbs. of limestone,	1 60
100 bushels of coke,	2 00
Labor at furnace,	2 00
Repairs,	1 00
Total,	$12 40

Which is not far from the cost of making iron at Lemont furnace during the latter half of 1877. The item of labor is in excess of what it should be, for, owing to the condition of the market, the furnace was not run to the extent of its capacity. By neglecting the mill-cinder, and using a mixture of two thirds coal ore, and one third mountain ore, the cost would be reduced, and the iron would be somewhat better. Considering the character of the ores, the amount of limestone used is evidently somewhat excessive.

In the calculation given above, the cost of material is in accordance with the contracts in force during 1877; but since the beginning of 1878 the cost of mining has been reduced ten per cent., which affects to that extent, the first, third, fourth, and fifth items.

Iron of good quality, which sold readily in Pittsburg, and gave full satisfaction, has been made at Lemont furnace for a few cents more than $11 per ton.

I have omitted all reference to the profits necessarily arising from the store, which seems, in a region like this, to be an essential adjunct to the furnace. A small village at once grows up round the furnace at a distance from trading centers, and the company is compelled to open a store. It is sufficiently clear that a store, having the trade of a community consisting of 600 or more employés with their families, must do a business of by no means insignificant

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proportions, and that the profits arising from such a business, if judiciously carried on, tend to make a very material difference in the net cost of producing iron.

Lemont has been taken as the representative, for the reasons already given; but it has no very decided advantages over the others. Just as good and just as cheap iron can be made at the other furnaces south from the Youghiogheny river. North from that river the cost of manufacture is greater, as the only ores are those from the Mountain beds, which cost more than that from the Pittsburg ore-bed, as the beds are thinner, and are at a considerable distance from the outcrop of the *Pittsburg coal bed.* South from the river, the ore, coal and limestone are together; the supply of each is enormous; the iron produced is good; Pittsburg, the market, is but 70 miles from Uniontown; two lines of railroad afford ample means of transportation and assure reasonable rates.

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CHAPTER XVII.

Zinc, Lead, Silver—Mineral Springs—Salt—Petroleum—Natural Gas—Limestone—Building Materials—Clays—Glass-sand.

Zinc, Lead and Silver. In Report KK, p. 109, it is stated that in southern Fayette county along the west slope of Chestnut ridge, small quantities of galena and zinc blende occur, but that the quantity is insufficient to be of any value. Early in 1877, however, I was informed that these ores had been analyzed and that the results showed them to be rich in zinc and lead, while one layer contained an almost incredible percentage of silver. The analyses have never been shown to me, but the statement was made with such assurance as to leave no room for doubt that some such results had been obtained in a chemical laboratory.

The locality of the ore is in Victor Hollow, a tributary to Georges creek, in Georges township of Fayette county, and the horizon of the rock is about midway in the Pocono sandstone. The exposure is:

1.	Gray sandstone,	1′ 6″
2.	Mottled fossiliferous sandstone,	0′ 10″
3.	Gray sandstone,	1′ 2″
4.	Similar to No. 2,	1′
5.	Dark shale,	0′ 8″
6.	Clay and sandstone,	3′

Nos. 2, 4 and 6 contain zinc blende and galena. In Nos. 2 and 4 these minerals occur only in scales and the quantity is easily seen to be minute; but in No. 6 they are in thin films, like fine veins, interlacing throughout the mass. These form weak lines in the rock, which, when struck, always breaks so as to exhibit a brilliant face of blende or galena. As the ore appears at every blow exposing a fresh surface, the quantity was readily over-estimated and some excitement was aroused. Specimens of all the layers, ex-

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cepting No. 5, were sent to Mr. A. S. McCreath for analysis, and the following results were obtained:

	Zinc.	Lead.
No. 1,	0.016	0.129
No. 2,	0.064	0.129
No. 3,	0.024	0.200
No. 4,	0.842	0.321
No. 6,	8.370	0.307

It had been reported that No. 1 contains one and a half per cent. of silver. A sample was therefore sent to Prof. Genth, the mineralogist of the survey, who subjected it to thorough examination and reported that it does not contain even a trace of silver. Copper also is said to have been found in No. 3, but, under the circumstances, it was thought altogether unnecessary to follow up the reported results any further, and no examination for copper was made.

As the occurrence of the galena and blende even in so small quantity is somewhat interesting, owing to the horizon, I made careful examination of the Pocono sandstone in the gorge of Redstone creek, on the National road, and in the gaps made by the Youghiogheny and Conemaugh rivers through Chestnut ridge to ascertain whether the occurrence is general or only local. A few scales of galena were seen in the Redstone gorge, but elsewhere the rock exhibits no traces of either mineral.

Nickel is reported to have been discovered in some pebbles found along the Youghiogheny river. These pebbles belong to the rocks of the vicinity and some of those shown to me were said to be parts of samples which had been subjected to analysis. They contain no nickel.

It is quite safe to repeat here what was said in KK—it is altogether improbable that any metal except iron will be found here in economical quantities. Occasional films of zinc and lead ore may arouse excitement, but the quantity will not suffice to repay the excited ones for their loss of time or waste of nervous energy.

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Mineral Springs. Chalybeate springs were seen at many places along the foot of the mountains.

The strongest observed is that belonging to Mr. McElroy, on Hendrick's run in Fairfield township of Westmoreland county. A boring made there for oil proved unsuccessful, but at nearly 300 feet below the surface it reached a large spring which flows energetically from a four-inch pipe and forms a little run. This is, no doubt, the spring which had caused a swamp somewhat further up the hollow and had deposited a considerable quantity of bog-iron ore, for that spring no longer flows. The water issuing from Mr. McElroy's spring is exceedingly chalybeate and already it has formed a large deposit of bog-ore in the meadow below the well-house. It has gained much reputation for medicinal qualities and, during the summer, visitors are quite numerous. No buildings have been erected for accommodation of visitors but there are rude arrangements for bathing.

Fayette Spring, at the east base of Chestnut ridge and barely half a mile south from the National road, is perhaps better known than any other spring in the valley. The water flows in moderate quantity, but the flow is steady, showing little variation throughout the year. In the reservoir which first receives the water, it is clear and sparkling, but in the large basin which next receives it, the water soon parts with much of its iron, which accumulates so rapidly that the basin must be cleaned out every day. This peculiarity is very marked and the condition was fully observed by me.

Before the completion of the Pennsylvania Central Railroad, this spring was patronized liberally by persons living in southwestern Pennsylvania, and at one time the buildings were quite extensive; but since the railroad was opened other springs are more easily reached, and the Fayette Spring has been abandoned. Now, however, it can be reached readily enough, as the railroads to Uniontown bring one to within six miles of the spring, and the rest of the journey is over the excellent National road.

The water had a high reputation as a specific for strumous

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diseases and as a general tonic. Many strange cures are reported and some of them seem to rest on a substantial basis. There can be no doubt that the water possesses valuable medicinal properties and that, as a chalybeate water, it has few superiors.

The following analysis was made by Prof. Genth, the water having been collected in 1875 by Mr. Chas. A. Young of this survey:

In one gallon of 231 cubic inches it contains:

Sulphate of magnesia,	0.25472
Sulphate of lime,	0.05542
Sulphate of soda,	0.19965
Sulphate of potash,	0.11525
Chloride of sodium,	0.08522
Bicarbonate of iron,	1.06709
Bicarbonate of manganese,	0.04795
Bicarbonate of magnesia,	1.53414
Bicarbonate of lime,	9.33441
Phosphate of lime,	0.04822
Alumina,	Trace.
Silicic acid,	1.19690
Nitrous acid,	Trace.
Carbonic acid, free,	0.38284
	14.32181

If the results of this analysis be compared with those of other springs, as given in Dr. Genth's second report of progress, it will be seen that the water of Fayette Spring compares very favorably with that of the most celebrated springs of which analyses are there given. From my own observations at the spring, I am inclined to think that the water analyzed was collected from the second basin, for the proportion of iron is much less than I had expected.

Other springs in this neighborhood were somewhat well known at one time; but all of them have been neglected for years, owing to the difficulty of reaching them. The railroads to Uniontown were not built until after the summer travel had been almost wholly diverted.

Salt. In some portions of Fayette and Westmoreland counties the manufacture of salt is by no means unimportant, though, for the present, it is not carried on to the full extent. Wells were seen on Sewickley creek, Jacob's creek

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and the Youghiogheny river; but the only wells now in operation are those belonging to Col. Painter on Sewickley creek, and those of Mr. J. A. Jameson at Salt Works, Mr. C. W. Taylor at Long Run, and the Bayard Works at Ellrod, all on the Youghiogheny river. The yield at present is not far from 100 barrels each day. In most cases the wells have been bored not very far from the lines of anticlinal axes and in most of them the salt is obtained from the Pottsville conglomerate. The salt is good and finds a ready market.

Petroleum. No productive oil-wells have been obtained within the Fayette and Westmoreland district, though the borings are numerous enough to determine whether the oil is present in economical quantities or not.

Small quantities of oil have been found in a boring on Turtle creek within Westmoreland county near the line of Allegheny; in one made about four miles southeast from Greensburg in the same county; and also in one made on Dunlap's creek near Brownsville in Fayette county. Other instances are reported, but these are the only ones with respect to which I could satisfy myself. All of these were bored on or very near the crests of anticlinal axes.

Natural Gas. Some of the old salt wells and deserted oil-borings still yield large quantities of gas. The old well near Brownsville shows the flow of gas as strong as it was forty years ago; an old salt well on Jacob's creek has yielded a constant flow for many years and from an oil-boring near it, made in 1865, the jet is still a powerful one. The Leechburg gas well was described in the coke report and the details need not be repeated here. As this is written, a newspaper paragraph states that, at McKeesport in Allegheny county, the boring at the National Tube Works has proved successful and that the supply of gas is very great.

Nothing as yet is known to justify the expectation that deep borings west from Chestnut ridge, within the counties of Fayette and Westmoreland, would find oil in paying quantities, if the opinion expressed in Report K, respecting the connection between the Greene county (Dunkard creek) oil

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and the disturbed and broken condition of the Mahoning sandstone be correct. Neither is anything certainly known about the presence of the Venango oil rocks under this region. Even were they present, there is reason to believe that their lithological character would differ from what it is in the northern region.

Limestone. There is limestone within the Fayette and Westmoreland district in quantity to supply all needs for agricultural, building and other purposes.

Within the Ligonier Valley, the limestones of the Lower Coal Series, though somewhat irregular in their occurrence, are found in nearly all the hollows on both sides of the valley, while, at many localities in the northern portion, the usually insignificant limestones of the Lower Barren Series become quite valuable for agricultural purposes. In addition to these, the Mountain limestone of the Lower Carboniferous is available in Laurel ridge south from the line of the Loyalhanna, and in Chestnut ridge south from the gap of Jacob's creek. Of these limestones, only that at fifty feet below the *Pittsburg coal bed* and some layers of the Mountain limestone yield a really good lime for building purposes. The other limestones in the valley can be used, but they contain many impurities and the lime even when carefully burned is apt to show much unslaked refuse.

West from Chestnut ridge the conditions vary much. Within the Blairsville trough from the State line to the Pennsylvania Railroad there is plenty of limestone for all purposes. The Upper Freeport limestone, though irregular, is often found along the side of the mountain and, where that is absent south from the Loyalhanna, the Mountain limestone is usually accessible. In the central portion of the trough are the great limestones of the Upper Productive Coal Series, which do not disappear until near the line of the Pennsylvania Railroad. Nearly all of these limestones are good enough for use on land, though many of them require care in burning, but there are few which yield a good strong lime for building purposes. These, however, are persistent and are quite thick.

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In the southern portion of the trough, much lime is consumed by the furnaces. These employ the Redstone, the Fishpot and, in one instance, the lower portion of the Great Limestone. The Redstone has been found to be of very good quality and contains very little insoluble matter, being in this respect equal to the best portion of the Mountain limestone. The Fishpot limestone is too deficient in lime and too rich in silicious matter to be a profitable flux. The lower division of the Great Limestone as shown at the Dunbar quarries is variable, but several of its layers are very good and fully equal to the Redstone limestone. At one furnace a limestone, lying but a few feet below the *Pittsburg coal bed*, has been used. It is very good.

The narrow strips of land marking the course of the several anticlinals are practically without limestone. There are in this region some bands of excellent limestone in the Lower Barren Series, but they belong so near the *Pittsburg coal bed*, that they are not available. The lack of limestone is painfully evident in the character of the soils, and the farmers are at some inconvenience. But the lime can be procured at slight cost and has been hauled in no case more than three or four miles.

The Greensburg trough has plenty of lime, though most of the beds belonging to the Upper Coal series are merely impure cement beds.

In the Lisbon trough the limestones of the Upper Series are thicker and most of them are better than in either the Blairsville or the Greensburg trough. The Lower Washington, the Waynesburg, the Uniontown and the Fishpot limestones are all good for agricultural purposes and some of them, especially the Fishpot and Waynesburg, yield a very excellent lime for building purposes.

In the northwest corner of the district there is a scanty supply of limestone and the community is largely dependent on the thin representative of the Great Limestone which occurs in Allegheny county.

The finest lime obtained within the district is that from the upper portion of the Mountain limestone. This is snow-white and, in that respect, fully equal to any of the cele-

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brated brands which are sent to market. The Silicious limestone, when burned, yields a white lime, which contains so much sand that, when slaked, it becomes a mortar.

Cement. Near Uniontown in Fayette county, the Uniontown limestone is burned and made into cement, which seems to be of good quality, for it is employed in constructing the Government dam on the Monongahela river, at a short distance above the State line. At some localities within the Lisbon trough, the layers at the base of the Great Limestone have been tried and have been found to yield a very satisfactory cement. A considerable portion of this mass will no doubt be found to be a good cement rock everywhere within the district. Such is its character in Greene and Washington counties as well as at every place within the Fayette and Westmoreland district where it has been tested.

Building Stone. Except in the extreme northwestern portion of the district, there is no lack of good stone for building purposes, and at some localities there are sandstones of such excellent quality, that, were there means of transportation, they might perhaps be shipped with profit.

In the Ligonier Valley, within Fayette county, the Morgantown sandstone is of excellent quality and it is well exposed at several places. It is compact, resists the action of the weather well and has a handsome grayish-olive tint. In the gap made through Laurel ridge by the Youghiogheny river, a fine grained, dark-brown sandstone was seen near the line of Somerset county. It resembles the brown sandstone used in New York City for veneering the fronts of buildings. When first taken from the quarry, it is soft and can be worked easily; but after exposure it becomes very hard and resists weathering admirably.

In the Blairsville basin the rock above the *Pittsburg coal*, which in the reports has been called the Pittsburg sandstone, is a durable stone, but unfortunately its structure is irregular, so that large blocks cannot always be obtained. The Connellsville sandstone, at about 70 or 80 feet below the *Pittsburg coal bed*, is quarried at many places along the eastern outcrop of the Upper Coals, and it is shipped from

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Connellsville. It is a good stone. At some localities within this trough, the Waynesburg sandstone is compact, but usually the layers are not more than four five inches thick, thick enough for ordinary purposes, but of no value for shipping.

In the "barren" strips between the troughs there are good sandstones, as the Saltsburg and Morgantown sandstones are often exposed, and in most cases they are compact, so as to yield large blocks of handsome stone.

In the Lisbon trough, south from the Pennsylvania Railroad, there is no lack for sandstones. The Pittsburg and Waynesburg sandstones are almost invariably good, though they are seldom such as would be valuable for shipment. They, however, almost always yield a durable material, which makes a neat wall.

Fireclays. Under all the coal-beds there are beds of fireclay, but of these there are few which possess any value.

A plastic clay occurring under the *Clarion coal bed* at Bolivar on the Conemaugh river is used in the manufacture of gas-retorts, being mixed with a non-plastic clay, belonging higher up in the series. Its excellence seems to be local. A very excellent plastic clay is found at New Geneva in the Terrace deposit. It is employed largely in the manufacture of pottery at Greensboro', on the Monongahela river. Good clays for the manufacture of ordinary brick are found at most localities in the subsoil.

Of the non-plastic fireclays there seem to be but two, that are of sufficiently wide distribution to be economically important. The lower of these, at but a short distance above the *Brookville coal bed*, is found along the west face of Chestnut ridge in Fayette county. It is from light to dark brown, very hard and makes a very durable firebrick. It is manufactured into brick at Lemont, Dunbar, and Connellsville. These brick are quite as durable as those made on the Ohio river and but little less so than the Mount Savage brick. Their inferiority to the latter is due largely, no doubt, to lack of care in selecting the clay. This is an important bed and is persistent even to West Virginia.

The Bolivar fireclay has a wide reputation, and, at one

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time, the brick made from it were thought to be hardly inferior to those from the Mount Savage region. It is well shown in the vicinity of Bolivar on the Conemaugh river, where for many years it has been digged to be made into firebrick. Unfortunately, the high price which firebrick commanded prior to the panic of 1873, induced the owners of the Bolivar works to relax the care used in selecting the clay, so that the bricks became inferior and their reputation was almost ruined.

This clay belongs at a few feet below the *Upper Freeport coal bed.* In Westmoreland county it was seen near Bolivar, on Laurel run near the base of Laurel ridge in Ligonier township, and at several other localities further south along that ridge; but along Chestnut ridge it was not seen within the county except near Bolivar. But in Fayette county, along the valley of Indian creek, this clay seems to be persistent, having been seen at many localities. It is present south from the Youghiogheny river at several places as may be seen by reference to the description of Henry Clay and Stewart townships of Fayette.

Analyses of two samples were made by Mr. A. S. McCreath, as follows:

I. Robert Hall, Ligonier T., Westmoreland Co.

II. —— ———, Potter, Stewart T., Fayette Co.

	I.	II.
Silica,	55.680	52.230
Alumina,	29.180	31.310
Protoxide of iron,	.837	1.008
Titanic acid,	1.490	1.680
Lime,	.130	.130
Magnesia,	.180	.165
Alkalies,	.245	.720
Water,	12.490	13.190
	100.232	100.433

In composition this clay approaches very closely to that obtained at Mount Savage. Mr. Franklin Platt has made extended comparisons of the fireclays of Pennsylvania with those from other localities, as may be seen by reference to

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his report on Clearfield and Jefferson counties. For his results the reader is referred to that report.

Glass-sand. Glass-sand of excellent quality occurs at New Geneva and Belvernon on the Monongahela and at Perryopolis on the Youghiogheny, in the terrace deposits. The sand at New Geneva as well as that at Perryopolis has been used in glass-making and at one time successful factories were in operation at both places. The sand obtained at Belvernon on the Fayette side of the Monongahela is somewhat inferior to that which is obtained on the opposite side of the river and is no longer digged.

Sand for glass-making and other purposes is made by grinding up sandstone at Dunbar, Layton and Sandworks in Fayette county. At Dunbar the upper portion of the Pottsville conglomerate is used; at the Sandworks, two miles above Connellsville on the Youghiogheny, the rock is evidently the Clarion sandstone; while at Layton one of the Lower Barren sandstones is taken.

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STRUCTURAL GEOLOGY.

CHAPTER XVIII.

SURFACE GEOLOGY OF SOUTHWEST PENNSYLVANIA.

The region referred to in this chapter embraces the counties of Fayette, Westmoreland, Washington and Greene, with portions of Allegheny and Beaver. Within this area, no traces of glacial drift occur, except along the banks of the Ohio river, where such material is found in the terraces, having been brought down from more northern counties by the Allegheny and Beaver rivers.

The measurements given in this chapter were made with the aneroid barometer, using some spirit-leveled line as the immediate base. In nearly every case, the measurements were made twice and few measurements are given aside from those which were verified in this manner, and where the verification was not made the fact is stated.

I. Benches along Cheat River and its Vicinity.

The Cheat and Monongahela rivers unite at about two miles north from the line between Pennsylvania and West Virginia. In the peninsula between these rivers and west from Chestnut ridge, a line of high knobs begins about a mile west of south from the mouth of Cheat river and continues southwardly to a little way beyond Morgantown in West Virginia. These hills are nearly alike in height and rise to about 600 feet above the rivers at their junction. They are rudely conical and their sides are terraced.

Stewartstown Terraces. Very near the top of one of these and about three miles from Cheat river is the village of

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Stewartstown, where, at 525 feet above the river, there is a distinct bench, which is the highest between Chestnut ridge and the Monongahela. Descending from this place to either stream the following series of benches may be seen:

	Feet above river.	Feet above tide.
Tenth bench,	525	1,295
Ninth bench,	465	1,235
Eighth bench,	425	1,195
Seventh bench,	360	1,130
Sixth bench,	330	1,100
Fifth bench,	280	1,050
Fourth bench,	210	980
Third bench,	180	950
Second bench,	80	850
First bench,	20	790

Ice's Ferry. Descending from the State line to Ice's ferry on Cheat river, about nine miles from the Monongahela, one sees the first, second, third, sixth, seventh and eighth benches of the series just given, but the fourth and fifth have been so disguised by erosion that they cannot be recognized. The benches mentioned are perfectly distinct, but above the third there are no transported fragments. The higher benches to the sixth are covered by an irregular deposit of sand with more or less clay, but the eighth shows no clay. On the opposite side of the river one finds rolled and polished stones, mostly of small size, occurring in great numbers up to the level of the third bench, but there they suddenly disappear.

Line Ferry. Here at three miles from the mouth of the river, the seventh, eighth and ninth benches of the Stewartstown series are distinct on the West Virginia side of the river, but the lower ones have been removed or are disguished by erosion.

In descending to this ferry from the north, one has difficulty in recognizing any of the benches, as the hill is abrupt and covered by wood; but rolled stones appear suddenly and in great numbers at 210 feet above the river and increase in number as well as size thence to the surface of the stream; while on the opposite side of the river, the trans-

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ported fragments are numerous up to the level of the fifth bench. On both sides, the higher benches are covered with sand, showing no polished fragments, but containing many small pieces of rock belonging to the immediate vicinity, which have been little affected by weathering and do not appear to have been subjected to the action of running water in any manner.

2. *Benches along the Monongahela River, between State Line and Georges Creek.*

Crossing the ferry at the mouth of Cheat river and taking the hill road to New Geneva, one reaches the third bench at half a mile from the river. It is covered by coarse sand mingled with clay, which has bowlders scattered throughout the whole mass. The fragments cease at 280 feet, the level of the fifth bench. The eighth bench is reached at the first cross-roads, somewhat more than a mile from Cheat river, and is covered by a deposit of sand, whose depth has not been ascertained. A flat-topped hill near by marks the level of the ninth bench.

Barely half a mile further on toward New Geneva there are several sand-banks and clay pits on the fifth bench. The pits yield a very good fireclay which is employed at the potteries in Greensboro', on the opposite side of the Monongahela river. At one of these pits, belonging to Mr. Eberhart, the detrital covering on this bench is 33 feet thick and consists of sand, 11 feet, clay, 22 feet, but the bottom of the deposit has not been reached. At the other pit, owned by Mr. Bear, the detritus is not less than 35 feet thick and consists largely of sand, there being in all only from 3 to 10 feet of clay.

At a little distance beyond the clay-pits, Mr. Eberhart's house is reached on the third bench. A well at the house is 23 feet deep and passes through nothing but sand. At a few rods further north along the road, the rocky shelf of the third bench is shown and the deposit covering it is found to be 35 feet thick from the curb of Mr. Eberhart's well. The fourth bench is hopelessly disguised by erosion

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and the detritus seems to be continuous from the top of the fifth to the shelf of the third bench. Throughout the whole mass bowlders are profusely distributed.

On Mr. Eberhart's property a black clay occurs in the covering of the fifth bench and is known as the "swamp clay," owing to the large quantity of half rotted wood which it contains. Here, amid the fragments of wood, the cupule of an acorn was found with a number of what were thought to be black haw berries. The latter were thoroughly carbonized, but the acorn cup was still tough and it was long kept as a curiosity.

This fifth bench is continuous along the river front from the State line to Georges creek, except where broken by streams, but sometimes it is so defaced by erosion as to be recognizable only with difficulty. It is handsomely preserved at Greensboro', on the opposite side of the river, where it shows vast numbers of rolled stones.

The clay, digged by Messrs. Eberhart and Bear, brings one dollar per ton delivered at the pits, and it is so good that it has given a high reputation to the Greensboro' potteries. The glass-sand from the same deposit is as good as the clay, and in former times, the Geneva glass-works were as successful as the Greensboro' potteries are now.

3. Benches along the Monongahela River, between Georges Creek and Redstone Creek.

Between the mouths of these streams few new measurements were made during 1876–7, and some of those made during 1875 are reproduced here from the report for that year. Some of these have been verified by repetition.

Below Greensboro' on the river hill, benches occur at 20, 180, 265 and 310 feet above the ordinary stage of water. At the mouth of Whiteley creek, Greene county, the third of the Stewartstown series is very distinct, and can be followed up the creek to the village of Mapletown. Polished fragments are numerous all the way. At the mouth of Muddy creek the fifth bench, covered with rolled and polished stones, is handsomely shown, and along the creek it is perfect as far as Carmichael's, where the coating is as thick as it is at the river.

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On Pumpkin run the same terrace is seen, and shows the same characters as on Muddy creek. At the mouth of Ten-mile creek, the first, third, and fifth of the Stewartstown series are shown, together with one at 30 feet above the fifth, which seems to be measurably persistent; while at two miles from the river, in Washington county, the eighth bench was seen.

The benches are distinct on both sides of the river, and at many places the stream has cut its channel way through them, just as the present channel way has divided the "bottom," so as to throw it partly on one side, and partly on the other.

4. Benches along Monongahela River between Redstone Creek and Pittsburg.

Below the mouth of Redstone, the benches are handsomely shown on both sides of the river, and at Belvernon the deposit covering the third has been opened to procure glass-sand for the extensive glass-works near that village. The structure of the deposit at these excavations is given in detail in Report K. The character of the material varies greatly and the thickness of the deposit is from 35 to 45 feet. The sand is of very excellent quality.

At Monongahela City the third and fifth benches are at 190 and 320 feet above low water mark or at an absolute altitude of 1110 and 1190 feet above tide. Between the third and fifth there is a bench at 290 feet above the river, but it is so ill-defined that its existence seems to be uncertain; but further down the river it is distinct, for a bench holding that place is reported from Peter's creek and Thompson's run. The third bench is well marked further down the river, being that along which the Pennsylvania Railroad runs from just below Braddock's station almost to Pittsburg.

The lowest bench at Monongahela City is 40 feet above the river or 750 feet above tide. Along this bench, which is the river "bottom," the Baltimore and Ohio Railroad runs for a considerable part of the distance below the mouth of the Youghiogheny river. It is the bench by the river side at Pittsburg.

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5. *Benches on Georges Creek.*

Along this stream, the third and fifth benches of the Stewartstown series are persistent, but rise, so that at Smithfield the fifth is 304, and the third 200 feet above the river at the mouth of the creek. The eighth bench is shown near Morris' Cross-roads on the south side of the creek, where its absolute level is the same as at Stewartstown.

Between Smithfield and Uniontown the third, fifth and sixth benches are seen to be persistent along the east side of Brush ridge, which marks the course of the Saltsburg axis. But in ascending the creek, the fifth has shown a constant increase in elevation, so that as the divide between Georges and Redstone creeks is approached, that bench takes the place of the sixth and finally becomes merged into the seventh. According to the barometer, the eighth bench is somewhat higher here than at the mouth of Cheat river, being 1206 feet.

6. *Benches on Redstone Creek.*

It is difficult to follow the benches along this stream, for, from the river to Upper Middletown, the valley is very narrow and the benches are indistinct. The bench, on which Uniontown is built, is evidently the same with the third of the Stewartstown series, which, at the mouth of the creek, is the highest bench carrying polished fragments. On the road leading from Uniontown to Connellsville, the eighth bench is reached very soon after leaving the National road, and it is again exposed near Lemont furnace, four miles from Uniontown, where the sixth bench is finely preserved at 90 feet below it.

The eighth bench is thoroughly persistent throughout the Redstone valley, along the base of Chestnut ridge, but it becomes a little obscure near the summit south from Mount Braddock, which is the divide between the waters of Dunbar creek and those of the Redstone.

On the old Pittsburg road, leading from Uniontown to Upper Middletown, the eighth bench is well shown, and,

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at the summit, the tenth is reached. The latter seems to be the chief plain along the east side of Brush ridge.

7. *Benches along the National Road.*

Between Uniontown and the Monongahela River. On this road the eighth bench is reached at the Poor House, almost immediately west from Uniontown. The tenth is seen at the schoolhouse, three miles from Uniontown, and a rude survey of the region, made with the level from this point, shows that bench to be the prominent plain on the ridge.

The ninth bench is reached on the hill holding the eastern outcrop of the *Pittsburg coal bed*, and thence along Dunlaps creek it is distinct during the passage of that stream through the arch of the Saltzburg axis.

Nine miles from Uniontown, a higher bench than any seen at Stewartstown is reached, and is marked by a number of flat-topped hills in the vicinity. It is 60 feet higher than the tenth, or 1350 feet above tide, and is the eleventh of the series. The tenth bench is reached again at Cooley's hill, and for a considerable distance beyond that the road runs on the ninth, which is very handsomely defined.

Thence to the toll-gate, within a mile of Brownsville, the country is so cut up by erosion that nothing can be determined; but beyond the gate, the river is seen and the road falls to the eighth bench, which has an absolute altitude of 1185 feet, if the engineers' station at West Brownsville was accurately identified. The other benches are sufficiently distinct along the river above Brownsville.

Between the Monongahela River and Washington. On the west side of the river the eighth bench is reached at one mile from the river and continues the important bench until one comes to the village of Kreppsville, where, at a short distance north from the road, the ninth is seen at 1225 feet. The road soon rises to that level and follows it to near Centerville. At Centerville it is again on this bench and a higher one is seen north and south from the village at 1245 feet, while still further north is the tenth at 1285 feet.

At Beallsville, the tenth is seen to be the important bench

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both north and south from the pike. Just west from that village is a high hill extending north and south, which seems to be a dividing ridge between the benches of the Monongahela and those belonging to the Chartiers Valley, though it is broken by Pike run at a little way north from the National road. On this hill one rises to 1420 feet and 1445 feet above tide, two splendid benches, while the top of the hill is little less than 1500 feet.

These higher benches are shown on the west side of the hill and again in ascending to Hillsborough, where another is seen at 1475 feet, and the top of the hill is 1505 feet.

Between Hillsborough and the second mile-post east from Washington, the road oscillates between the 1380 and the 1445 feet benches. Beyond that post, the surface falls off and one comes down to the valley of Chartiers creek. The railroad depot at Washington is very near the place of the sixth bench.

8. Benches on Chestnut Ridge South from the Youghiogheny River.

Near Springhill furnace, the eighth bench stands out from the mountain side for more than 400 yards on the south side of Drague's hollow. It is very distinct thence southwards to the State line. This bench remains quite distinct as far north as the middle of Georges township, but thence northward, within the area of Redstone creek, the lower rocks have been removed by erosion and only the hard Pottsville conglomerate remains to form the face of the mountain. Where that rock forms the face of the ridge, no such traces of the benches remain as would serve to identify them.

On the summit of the National road the surface is covered by a reddish sand almost free from clay. This point is about 2400 feet above tide. A well marked level occurs on the Seaton road, 180 feet higher, which extends along that road for nearly two miles south from the pike, and is covered with loose sand from disintegration of the Pocono sandstone.

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Some of the low gaps, which extend to but a short distance below the summit are beautifully terraced. The gorges of the larger streams are usually so narrow and have walls so abrupt that no traces of benches remain and it is doubtful whether any ever could have existed in the most of them.

9. Benches along the Youghiogheny River.

At McKeesport the river "bottom" is 765 feet above tide; from that point it is continuous to Connellsville, at the mouth of the Chestnut ridge gap, where it is 894 feet above tide.

Opposite Connellsville a fine bench is seen at barely 200 feet above the stream, which is covered by a thick coat of debris containing many huge fragments, all of them having rounded surfaces. The same bench occurs at Perryopolis, where at one time sand was obtained for glass-making.

This terrace rises much more slowly than the river bed above Connellsville, for at Ohiopyle Falls it is barely 140 feet above the river. While this bench was the bed, the river flowed directly across the neck of the peninsula at the falls.

At Confluence, at the east end of the gap through Laurel ridge, the river bottom, which is only 765 feet at McKeesport, is 1346 feet above tide. A fine bench was seen southwest from Confluence at 1820 feet above tide.

10. Benches in Westmoreland County West from Chestnut Ridge.

On the Bedford pike, half a mile west from Jacksonville and near the west line of the county, there is a bench at 1190 feet above tide, the eighth of the Stewartstown series; while at the village is one at 1230 feet, the ninth. These are well shown both north and south from the pike, while the tenth is distinct north trom Penn station on the Pennsylvania Railroad. West from Greensburg the twelfth is seen at 1380 feet; the ninth at 1242 feet.

Northward from Greensburg on the road to New Salem, benches were found at 1185, 1270 and 1300 feet. At New

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Salem the highest point is on the eleventh bench, which in that portion of the county is of wide extent.

Near Latrobe on the Bedford pike, benches were found at 1050, 1105, 1185 and 1240 feet above tide, representing the fifth, sixth, eighth and ninth of the Stewartstown series. The highest plain near the pike is about 1450 feet above tide.

11. Benches in the Ligonier Valley.

On the National Road. There was no way of verifying the measurements made along this road and the only base is the determination of the summit of Chestnut ridge, made during the survey for the National road. Between that summit and Farmington the following benches were seen: 2155, 2060, 1965, 1880 feet above tide.

South from the National road, the Laurel ridge loses its mountain character and breaks down into a level country known as the "Glades," which reaches over into West Virginia. Though thus breaking down the ridge loses little of its height, and the "Glades" are not far from 2200 feet above tide. In general character this plain is like the benches.

Near the Loyalhanna. Between Ligonier and Stahlstown, on the divide between Four-mile run and the Loyalhanna, the following benches were found: 1690, 1570, 1520, 1480, 1390, 1245 feet above tide. These measurements were verified by reference to the levels of the Ligonier and Latrobe railroad at Ligonier.

12. Benches in Somerset County.

Within sight of Myersdale on the Pittsburg and Cumberland railroad, there are three well-defined benches at 2123, 2288, and 2323 feet above tide, as determined by barometer from the railroad level at the station. These benches are persistent throughout this portion of Somerset county.

Resume of the facts.—Looking now at the facts thus far given, we see that they show the existence of two sets of benches, in one of which, the higher, the individuals show

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an almost unvarying level, while in the other or lower set, the members have no definite altitude with respect to tide, but vary much in level as do the beds of the streams along which they are found. Arranged in tabular form, we have first:—

The Benches of the Upper Series.

		Above tide.
1.	Chestnut Ridge, Seaton road,	2,580′
2.	Chestnut Ridge, National road,	2,400′
3.	Top bench, Somerset county,	2,323′
4.	Middle bench, Somerset county,	2,288′
5.	Bottom bench, Somerset county,	2,123′
6.	Bench near Confluence,	1,820′
7.	Sixth bench of Loyalhanna,	1,690′
8.	Fifth bench of Loyalhanna,	1,570′
9.	Fourth bench of Loyalhanna,	1,520′
10.	Third bench of Loyalhanna, also at Hillsborough and Beallsville,	1,475′
11.	National road, Washington county,	1,445′
12.	National road in Washington county,	1,425′
13.	Second Loyalhanna bench, also National road near Beallsville and Hillsboro',	1,380′
14.	National road east from Brownsville,	1,350′
15.	Tenth bench of Stewartstown series,	1,290′
16.	Intermediate bench, Dunbar Creek, Possum Creek, Greensburg,	1,270′
17.	Ninth bench of Stewartstown series, first Loyalhanna bench,	1,240
18.	Eighth bench of Stewartstown series,	1,195′
19.	Seventh bench of same series,	1,130′
20.	Sixth bench of same series,	1,100′

The elevation of low water at Pittsburg, as used by the City Surveyor's office, is 699 feet above mean tide.

The altitudes given in the table are, as nearly as may be, the mean of the measurements. At the same time, no bench, except No. 17, shows any material variation, and I am inclined to believe that I have confounded there two benches lying close together. The benches from the National road in the Ligonier valley have been omitted because their position was not determined with certainty.

The variations in level observed in the individual benches of this series are so slight, except in No. 17, that I think them due either to variations in the barometer or to the fact, that, in every case, I attempted to take the highest point on the

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bench, so as to determine the top of the detrital deposit. As that deposit has suffered more or less from erosion, one cannot, even with the best of instruments, get a series of measurements which will tally accurately. The extreme of variation even in No. 17 is barely 20 feet, so that one is fully justified in regarding these benches as practically horizontal.

On these benches the deposit consists of sand with occasionally a little clay, the sand greatly predominating. No rolled or polished fragments of rock occur; and such fragments as were seen belong altogether to rocks found in the immediate vicinity. There is no evidence that running water had ever passed over these plains, so that if the water were moving its effects must have been within a limited space.

The lower series of benches includes those which have no fixed level, but are preciously analogous to the "bottoms" of the streams which flow below them. In tabular form this series may be given as follows:

1.	Fifth bench of Stewartstown series, ...	1,050′
2.	Fourth bench of same, ...	980′
3.	Third bench of same, ...	950′
4.	Second bench of same, ...	850′
5.	First bench of same, ...	790′

The elevations given in this list are those observed at the mouth of Cheat river, and are used only to show the intervals between the benches at a locality, where the series is well exposed.

It has been said that no absolute altitudes can be assigned to members of this series; the lowest bench is 790 feet at the mouth of Cheat river, but at Pittsburg it is only 765 feet; the third bench is 950 feet at mouth of Cheat, and 920 feet at mouth of Turtle creek in Allegheny county. The variations on Georges creek, the Youghiogheny, and many other streams fully illustrate the great changes in altitude.

As mentioned in Report K (1875), these lower benches are merely shelves cut out of the rock, on which are spread thin deposits of irregularly stratified, or, in many cases, wholly unstratified detritus. At some localities the lower

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portion is almost wholly clay, and the upper portion sand, but usually one of these occurs in pots in the other.

Transported fragments, polished, appear with this series. Those in the Monongahela river benches have been brought from the south and east, for no rocks are represented except such as occur in the mountains traversed by tributaries to the Youghiogheny and Monongahela. The detrital covering is greatest on the third and fifth benches, where it is of considerable economic importance, the third yielding the glass-sand of Belvernon, and the fifth, the glass-sand of Perryopolis and the fireclay of New Geneva.

The upper limit of rolled stones shows some perplexing variations, which can be accounted for, in most instances, only by supposing that the higher benches of the series have been eroded from one side of the stream. On Cheat river, near Ice's ferry, nine miles from the mouth of the river, the upper limit is the third; near the Line ferry on the same river, no fragments occur on the north side above the fourth, though on the opposite side they are numerous up to the fifth; on the south side, at Point Marion, the fourth terrace is the upper line, but on the north side fragments are numerous up to the fifth. Along the Youghiogheny, the fifth bench, or its continuation, is the upper limit of transported fragments.

After passing the third bench, the Monongahela seems to have suffered changes in its channel way. Below Belvernon, there is distinct evidence that it now follows a very different line from that along which it flowed when its bed was on the third bench. Near Pittsburg the change was more serious. Between the site of Braddocks-Field and the Allegheny, the river followed a direct course, the old channel being followed now by the Pennsylvania railroad from Braddocks station to near Pittsburg. The present course of the river is very tortuous. A similar change is shown on the Youghiogheny at Ohiopyle Falls, where the old channel on the fifth bench crossed the neck of the peninsula, while the new channel way curves round that long peninsula and makes a close horse-shoe bend.*

* As the discussion of these facts has no practical bearing, I have withdrawn it from this report and it will appear elsewhere.

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Chapter XIX.

The Anticlinal Axes of Southwestern Pennsylvania and their Mutual Relationship.

The following anticlinals have been described in Reports K, KK, KKK, as occurring within the districts covered by those reports, viz: the counties of Greene, Washington, Southern Allegheny, Westmoreland and Fayette; and they run in rudely parallel lines from N. N. E. to S. S. W. across the region in the following order, commencing at the west:

1. Bulger.
2. Claysville.
3. Washington.
4. Pinhook.
5. Waynesburg.
6. Saltsburg.
7. Blairsville.
8. Chestnut ridge.
9. Laurel ridge.

East from the Laurel ridge to the Allegheny mountains as shown in the reports on Cambria and Somerset counties, the important axes are (taken in the same order from west to east):

10. Viaduct axis.
11. Negro mountain.
12. Allegheny mountains.

Nos. 1 and 2 are synonyms. The axis is shifted eastward in northwestern Washington county and hereafter it may be known as the Bulger-Claysville axis, unless it should prove to be identical with some previously named anticlinal north from the Ohio river.

In Report K, the Claysville axis was hesitatingly identi-

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fied with a distinct anticlinal crossing the Ohio river at Wood's run, three miles below Pittsburg. As will be seen by reference to that report, much obscurity existed respecting the relations of the Wood's Run and Washington axes, and the latter was supposed to disappear or, at least, to be merged into the former at no considerable distance north from the Ohio river. A reëxamination of the region shows that the Washington and Wood's Run axes are identical, the axis having been shifted southeastwardly near the line of the Ohio river, and that to this shifting is due the irregularity of dips observed near the river in Allegheny county. A precisely similar condition exists in Sewickley township of Westmoreland county, where the Waynesburg axis is thrown off and the dips have been so deranged as to make mining very complicated. Prof. I. C. White has shown that the Wood's Run axis is the same with the Brady's Bend anticlinal, and the latter name must take precedence of "Washington" which I applied to it in Report K. The others remain as previously given, so that the list is now:

1. Bulger-Claysville axis.
2. Brady's Bend axis. Washington of Report K.
3. Pinhook axis. Includes Peter's Creek of Rep. K.
4. Waynesburg axis.
5. Saltsburg axis. Fayette County axis of Rep. K.
6. Blairsville axis.
7. Chestnut ridge.
8. Laurel ridge.
9. Viaduct axis.
10. Negro mountain.
11. Allegheny mountain.

The deportment of the first seven axes is described in reports K and KK, where I have shown that they do not follow direct lines, but that at irregular distances they have been shifted toward the southeast, while the general course or trend is north-northeast and south-southwest. I have shown also that, in the first six, the altitude diminishes southward, though owing to the shallowing of the synclinals and the general elevation of the whole region northward, the

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axes seem to lose strength in that direction. In those reports, it is shown also that the six axes terminate southward *en echelon*, each one reaching further south than the one adjoining it at the west. Thus the Bulger-Claysville axis practically disappears before reaching the southern line of Washington county; the Brady's Bend axis is strong at that line, but evidently breaks down rapidly after passing into West Virginia; the Pin-Hook axis is barely perceptible on South Ten-mile creek in Greene county; the Waynesburg axis has almost disappeared at the southern border of Greene county; while the great Saltsburg axis, having previously either absorbed or been absorbed by the Blairsville axis, is over-ridden by Chestnut ridge at not more than ten or twelve miles south from the State line.

The anticlinals within the coal-field of eastern Ohio show the same features.

In Report KK, the axis of Chestnut ridge was traced to but a short distance south from the State line. A few additional notes respecting its course were obtained during 1877. In Report KK it is mentioned that this axis is thrown off toward the southeast near the line between Fayette and Westmoreland counties, and a hypothesis is there offered to show that the line, though thrown off, is not broken. The sidethrow was observed at the headwaters of Jacob's creek, but the eastern fold is very gentle there, barely more than sufficient to cause a flattening of the dip and to bring up the *Upper Freeport coal bed* on Four-mile run in apparently a most abnormal manner. On the Loyalhanna and Conemaugh, there is a gentle anticlinal which is on the line of this offset, but the relation could not be made out with absolute certainty, though every probability seemed to favor the supposition that the Chestnut ridge of Fayette county gradually dies out in Westmoreland county, just as the Chestnut ridge of Westmoreland gradually diminishes in Fayette until it is an insignificant fold at Connellsville on the Youghiogheny. Each portion over-rides the other.

Chestnut ridge attains its greatest strength very near the National road in Fayette county, as may be seen by reference to the map, for there a large patch of the Devonian

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rocks is exposed very near the crest of the mountain. But thence southward the axis diminishes, the outcrops of the Pottsville conglomerate gradually approach the axial plane, and at length before reaching the gap of Cheat river that rock crosses the crest unbroken.

But just south from the gap of Cheat river the axis of Chestnut ridge seems to divide and its relations to that of Laurel ridge become a little obscure. A strong axis continues in the direct line, while a somewhat weaker one, striking off, follows a rudely southeast course toward the Kingwood axis of Prof. W. B. Rogers, which is the Laurel ridge of Pennsylvania.

The direct axis of Chestnut ridge, following a southwestward course, constantly decreases in height south from the gap of Cheat river. On Decker's creek the Pottsville conglomerate forms the arch and carries on it patches of the Lower Productive Coal Series. Beyond that creek, the flattening of the fold is very marked, so that at the gap made by the Tygart's Valley river, the Pottsville conglomerate is the lowest rock exposed, and the Lower Productive Coal Series passes over the fold unbroken; while at the gap made by the West Fork of the Monongahela river, the anticlinal is but slight, being crossed by the *Pittsburg coal bed* and barely exposing the *Upper Freeport* in the bed of the river. On the Staunton and Parkersburg pike, west from Weston, fully 200 feet of rock are shown above the *Pittsburg coal bed* on the crest of the axis, and the fold has become so insignificant as to have no effect on the topography, the dip on either side being less than one degree. Beyond the line of that pike, the axis has not been traced, but its disappearance may be looked for within a distance of little more than fifteen miles.

The structure of the region between this and the eastern axes in northern West Virginia is exceedingly complicated. There is no room for doubt that, at a very little way south from the gap of Cheat river, a new axis begins which cuts off the Ligonier Valley of Pennsylvania. This, the Preston axis of Prof. W. B. Rogers, clearly follows a course, which must soon bring it into the Laurel ridge or Kingwood axis,

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thus connecting the two great folds, both of which have diminished greatly in importance. This conclusion is very much strengthened by the condition observed in the Ligonier Valley within Pennsylvania. By reference to the first chapter of this report it will be seen that the Ligonier Valley shows a constant rise southward from the Loyalhanna to the State line, or as far as trustworthy levels could be obtained. It is mentioned there that the synclinal becomes not only shallower but narrower southward, so that it must point out at no considerable distance beyond the State line. These observations harmonize with those of made by the Virginia geologists many years ago. We may therefore regard the Ligonier Valley as a canoe-shaped synclinal, pointing out in Preston county of West Virginia; while south from the gap of Cheat river another similar synclinal begins, widening and deepening southward, which contains the Newburg patch of the Upper Productive Coal Series.

The axis of Laurel ridge, forming the eastern boundary of the Ligonier Valley is a stronger axis than that of Chestnut ridge, and the Lower Carboniferous rocks are exposed along the crest from the Conemaugh river to the State line, except at the National road, where there is a band of the Pottsville Conglomerate. This axis rapidly decreases in strength southward from the Youghiogheny river, for at Sugar-loaf mountain, near that river, the Mountain limestone is near the top of the knob, whereas on the National road the Pottsville Conglomerate crosses the crest, though the altitude is considerably less than that of Sugar-loaf summit.

Laurel ridge axis enters West Virginia at the northeast corner of Preston county, or very near the angle formed by Pennsylvania, Maryland and West Virginia. It is not the Briery axis of Prof. W. B. Rogers, but is the same with that which he named the Kingwood axis. Its course through Preston county is given in the Virginia Report for 1839, but no details respecting its course through Tucker county are accessible. It is however sufficiently clear that this axis suffers a sidethrow toward the east not

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far south from the line of the Baltimore and Ohio Railroad, for in Randolph county of West Virginia the great Tygart's Valley anticlinal shows at its western base the remains of a strong axis, which flattens the dip for twelve miles along the Staunton and Parkersburg pike.

That this interruption of the dip represents the Laurel ridge or Kingwood axis is quite clear. The great Tygart's Valley anticlinal in Randolph county of West Virginia, results, according to Prof. W. B. Rogers, from the union of the Briery and Backbone axes of West Virginia which lie directly east from the Laurel ridge axis. Between this great anticlinal and that of Chestnut ridge there is no fold along the Staunton and Parkersburg pike, unless one be represented by the flattening referred to. The Laurel ridge or Kingwood axis has been traced to only a few miles south from the line of the Baltimore and Ohio Railroad, and where it is crossed by the Northwestern pike, west from Evansville, it is still strong. Had it continued in a straight line to the Staunton and Parkersburg pike, it should have reached that road about midway between Weston and Buckhannon; but no evidence of any anticlinal exists there. On the contrary, the synclinal between Chestnut ridge and the next axis east occurs between those towns, so that unless Laurel ridge be represented by the flattening, that great axis has disappeared before reaching the pike. But this is altogether unlikely, for the weaker axis of Chestnut ridge extends southward beyond that pike; and in addition, no axis has been discovered between the Briery and the Kingwood; so that the great interruption of the dip in eastern Upshur county of West Virginia must represent the Laurel ridge axis of Pennsylvania. That axis, therefore, has suffered a sidethrow similar to those seen in all the other axes lying west from it.

At no considerable distance south from the line of the Parkersburg and Staunton pike, there are no axes west from the Tygart's Valley anticlinal, save insignificant rolls, which cannot be followed with the barometer.

The great Tygart's Valley anticlinal of the Virginia reports is made up of Negro mountain and the Allegheny

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mountain of Pennsylvania. These two bold axes were found by Mr. W. G. Platt to be rapidly approaching each other at the southern border of Somerset county, in Pennsylvania, (while the former swallows up the Viaduct axis at but a short distance south from the State line,) and Prof. W. B. Rogers states that they unite before entering West Virginia. In Randolph county of West Virginia the axis is represented by Cheat mountain and Rich mountain, between which the Tygart's Valley river flows in an anticlinal valley. No details respecting its southern prolongation are at present attainable, but on the Great Kanawha river, where this axis should be, there are only insignificant rolls in the strata.

Thus far, then, it appears that all the anticlinals west from the Alleghenies of Pennsylvania are frequently shifted toward the southeast; that these shiftings are due in measure to the same cause is probable, since in several instances the axes are all shifted on a line running rudely northwest and southeast. These successive throws narrow the synclinals so that some of them are canoe-shaped at the south, where the western anticlinal has been over-ridden by its eastern neighbor. This consolidation of the axes is so rapid and effectual that at the Parkersburg and Staunton pike, barely 70 miles south from the Pennsylvania line, there remain of all the Pennsylvania axes west from the Alleghenies only those of Laurel and Chestnut ridges, which are reduced in the former case to a simple flattening of the dip, and in the latter to a gentle fold of utterly insignificant proportions, while at only a few miles south from the Staunton pike there is a broad expanse of country between the Rich mountain and the Ohio river, with its dip broken by no ancient anticlinal. The only interruption is caused by the Oil-break, which is of comparatively recent origin, as is shown by its course, as well as by its structure.

Examinations by Prof. W. B. Rogers and Prof. Lesley have shown that the region of great faults occurs in the Virginias and southward, while northward from southwest Virginia the faults decrease in number as well as in depth. Prof. Fontaine, during his study of the rocks along the New

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river in West Virginia, conceived that some intimate relation must exist between the presence of these faults and the absence of anticlinals in the west. He supposes that the disturbing agency acted with such violence within the narrow zone marked by these faults as to exhaust itself there, and to leave the region at the west undisturbed.*

It is more than probable that this process of consolidation by successive merging of each axis into that adjoining it at the east continues southward, for the Appalachian Chain, which in N. Lat. 40° extends from eastern Pennsylvania almost to central Ohio, becomes only a few miles wide in Alabama, and soon disappears by the dying away of the only remaining axis.

* This hypothesis was afterward worked out in detail, and published by Prof. Fontaine in the American Journal of Science for January, 1876.

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Chapter XX.

Age of the Anticlinals.

That the anticlinals are of ancient origin long ago suggested itself to me, while engaged in the study of the coal measures of Ohio; but evidence, which could be regarded as satisfactory was not obtained until after the study of the Upper Coal groups in southwestern Pennsylvania during 1875 and 1876.

Three classes of facts bear upon this subject, those relating to ancient valleys of erosion, those relating to intercalated groups, and those relating to the distribution of the limestones in the several synclinals. Let us look at these separately.

Ancient Valleys of Erosion.

In Report K, P. 324, I described an ancient valley of erosion, which occurs on the Panhandle railroad near Fort Pitt station in Allegheny county. At the east end of a cut there the following section is exposed:

1.	Sandstone,	25′
2.	Sandy shale,	20′
3.	Variegated shale,	4′
4.	Limestone,	1′ 6″
5.	Variegated shale,	10′

But midway in the cut the sandstone, No. 1, abruptly displaces the rest of the section, and passes below the level of the track.

At Fort Pitt station, perhaps one fourth of a mile west from the cut, the sandstone is fully 75 feet thick, and begins at 40 feet below the *Pittsburg coal bed*, so that it includes the Connellsville sandstone. From this station to perhaps three fourths of a mile beyond Walker's station,

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the sandstone forms a bold bluff alongside of the run, up which the railroad passes; but at nearly midway between Walker's and Hays' station, the bluff suddenly disappears, its place being taken by a grassy bank with gentle slope, while at Hays' station the following section was obtained, the lower portion being exposed in a cut below the station, just beyond the disappearance of the sandstone bluffs:

1.	*Pittsburg coal bed*,	11′
2.	Interval,	70′
3.	Flaggy sandstone,	20′
4.	Shale,	3′
5.	Limestone,	2′
6.	Interval,	40′
7.	Limestone,	1′ 6″
8.	Sandy shale,	35′

No. 5 is the limestone, which is replaced at Fort Pitt. Here it is 75 feet above the track, which makes the total rise of the strata between the appearance and disappearance of the sandstone nearly 150 feet. The dip of the rocks is about 80 feet per mile, while that of the sandstone is not far from 40 feet, since at the western side the lower as well as the upper limestone has been replaced by the sandstone. Both of these rocks must have been above the surface at the time the erosion took place, and the dip must have been about 40 feet per mile in a southeast direction; but this sandstone belongs to the upper part of the Lower Barren Series, *so that the Bulger-Claysville axis must have existed, in this locality at least, as a distinct fold before the formation of the Connellsville sandstone.* This eroded valley was traced northward for some distance, its peculiar sandstone having been recognized in the same position on the Steubenville pike. Its extent southward is unknown, since in that direction, the horizon is nowhere exposed within the State of Pennsylvania.

On the west side of the Bulger-Claysville axis and at a short distance east from Oakdale station on the Panhandle railroad, the same phenomena are even more fully exposed, for there in a succession of cuts, both sides of an ancient valley are shown. This valley is filled with a sandstone

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precisely similar in character and relationship to that occupying the valley between Fort Pitt and Hays station.

Next east from the Bulger-Claysville is the Brady's Bend or Washington axis. This anticlinal crosses the Monongahela river opposite Pittsburg, and passes almost directly through the Sheffield steel works. Just east from that locality, and a little below Birmingham station, the following section is exposed alonside of the railroad:

1.	Limestone,	8′
2.	Shale,	24′
3.	Green limestone,	1′
4.	*Coal bed*,	1′
5.	Shale,	6′

Just before reaching the Steel works, the shale, No. 2, cuts out Nos. 3, 4 and 5, and extends to an unknown depth below the track. This gap occupies the exact plane of the axis and extends for many yards east and west. On its eastern side the Green limestone dips east and on the west side it dips west. The shale filling the gap is similar in composition to that in the main portion of the bed, but is comparatively structureless, being without regular bedding. How far this condition extends is not known. At the south under this axis the horizon is concealed, while northward it has been cut away by the rivers for a long distance.

A very similar case of ancient erosion is found on the Conemaugh river, almost directly under the crest of the Blairsville anticlinal. It is thus described in the Report of the First Survey, Vol. II, P. 600:

"In the exposure, which is several hundred yards long, the rocks exhibit striking changes in character; thus, at one point, the shale under the sandstone is 10 feet thick, but in a few rods becomes a sandstone, which rests directly on the coal. The shales between the coal seams thicken and thin variously. At one place where this appearance presents itself the coal seemingly terminates in the sandstone. Near the place, where these disappear with a west dip beneath the water level, the massive sandstone resting on the coal changes wholly to shale for a thickness of 12 feet; the sandstone then presents a vertical wall, 40 or 50

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feet thick, in coarse gray massive strata, with irregular lines of deposition along the canal."

Similar erosions much smaller in extent, were seen at many places along the axes. They account for any variations in details, which one finds in comparing sections obtained in following up an anticlinal.

In the Annals of the New York Lyceum, Vol. X, P. 237, I have described a case of successive erosions, which exists in western Belmont and Harrison counties of Ohio, on the eastern slope of the Cadiz anticlinal. The section on Stillwater creek, in the north central portion of the former county is as follows:

1. *Coal X*, ... —
2. Sandstone, ... 35′
3. *Coal IX*, ... —
4. Limestone, ... 70′
5. Shale, ... 5′
6. *Coal VIII—Pittsburg*, ... —

Beginning at Barnesville on the Central Ohio railroad and following a line, lying about 5 miles west from the locality of the section just given and passing north through the village of Sewelsville into Moorfield township of Harrison county, we get the following three sections:

1. Coal X, ...	. . . .	Coal X.	. . .		
2. Sandstone, ...	55′				
3. Coal IX, ...	. . . .	Sandstone.	105′		
4. Limestone, ...	5′ 6″	. . . . .	. . .	Sandstone.	40′
				Limestone.	4′
5. Sandstone, ...	40′	. . . . .	. . .	Shale.	5′
6. Coal VIII, ...	. . . .	Coal VIII.	. . .	Coal VIII.	

All of these sections were obtained on the east side of the anticlinal, but a similar case occurs on the west side in Harrison county, for, at the village of Deersville, the *Pittsburg coal bed* (VIII) is overlaid by 70 feet of sandstone; whereas at but a short distance north, on the same side of the axis, the Stillwater section is reproduced, though with the intervals between the coal beds reduced.

A comparison of the sections shows a double erosion, one before the formation of *coal IX* and the other after it. For the limestone in the Barnesville section is the upper portion

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of the limestone, No. 4, of the Stillwater section. The earlier erosion was more effective at the south, for at Barnesville and Sewelsville it has not only removed the greater part of that limestone, but it has also trenched deeply into the lower division of the *Pittsburg coal bed*, in which there are now enormous sandstone horse-backs; whereas at Moorfield, it has not removed the lower portion of the limestone. The second erosion, however, was more effective at the north, for at Barnesville it spared the limestone and the overlying *coal IX*, but at Sewelsville it left no trace of either.

An instance of double erosion may be seen on the Pennsylvania railroad just west from Penn station in Westmoreland county. In the east end of the cut, the section is:

Sandstone,	60′
Sandstone, with streaks of *coal*,	6′

At a few rods within the cut the sandstone, containing the *coal*-streaks, goes under the track, and within a few feet, further west, a limestone, not far from 8 feet thick at most, comes in suddenly. This lasts for about 20 yards, when it is cut off as suddenly as it appeared. Following the side-track leading to the tipple of the Foster mines, and beginning at the east end of the cut, one sees the same phenomena. The limestone comes in and continues quite to the tipple, beyond which the hill is cut off, and the limestone or its place is not exposed. It is very clear that the limestone has been removed by erosion, occurring not long after its formation. Going still further into the cut, along the main road, one finds the sandstone itself cut away and replaced by a soft yielding shale. This marked feature in the cut led one of the engineers to say that if the railroad had been run the other way, the cost of making the cut would have been much less. Without doubt, then, there are here the evidences of two erosions, one to form the gap in which the sandstone is deposited, and the other to make the gully in the sandstone, now filled by the shale.

The limestone in this cut is the Great limestone, and the *coal-bed*, of which fragments occur in the sandstone, is the *Redstone*, the first above the *Pittsburg coal-bed.*

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Intercalated Groups of Rocks.

In the southern portion of Greene county, the Nineveh synclinal shows an intercalated group of rocks, which is wholly wanting in all other portions of the field except within the Waynesburg trough in the same county. This group is absent from the anticlinals, except in the extreme southern part of the county, where it barely crosses the Pinhook axis into the Waynesburg synclinal on Dunkard creek.

The following section was obtained within the Nineveh synclinal on Gray's Fork of Ten-mile creek:

1.	Limestone X,		2′ 6″
2.	Interval,	100′	
3.	*Dunkard coal bed*,	2′	
4.	Limestone IX B,	3′	Interval 285′
5.	Interval,	30′	
6.	Limestone IX A,		
7.	Interval,	140′	
8.	Limestone VI,		5′

The interval, No. 7, includes Limestones VII and VIII, and the *Nineveh coal bed* is exposed above Limestone X. But on Brown's Fork of Ten-mile creek, not more than four miles away towards the north, the following section was obtained:

1.	Limestone X,	2′
2.	Interval,	130′
3.	Limestone VI,	8′

Here the *Nineveh coal bed* has been mined at 39 feet above Limestone X. As may be seen by reference to the descriptions of Limestones VI and X, given in Report K, those beds cannot be mistaken for any others, while, in addition, the great Fish Creek sandstone is present at both localities under Limestone X.

It is very evident, then, that in this distance of four miles, 155 feet of measures, including a *coal bed* and two well-defined limestones, have disappeared finally, for they are found at no point further north. But they are persistent as far south as the West Virginia line, beyond which no attempt has been made to trace them. The *Dunkard coal bed* and its limestones have been fully

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identified in Aleppo, Richhill, Center, Gilmore and Jackson townships of Greene county, while the *coal bed* is persistent in Springhill township of the same county, though its limestones, like many others of the series, are absent. For the most part and especially toward the north this group is confined to the central portion of the trough; it thins out in each direction toward the anticlinals and sections obtained near the crests of the axes show it to be absent.

In by far the greater portion of the Waynesburg synclinal, that between the Waynesburg and Pinhook axes, the upper rocks of the Upper Barren Series have been removed by erosion or they are deeply buried under debris, so that details can be obtained only with great difficulty. A section obtained by Prof. I. C. White on the high ridge separating Greene and Washington counties, shows the presence of the *Dunkard group* in that portion of the synclinal. It is as follows:

1.	Limestone X,		Fragments.
2.	Interval,	150′ ?	
3.	*Dunkard coal bed*,	1′ 2″	
4.	Interval,	50′	Interval 270′ ?
5.	Limestone IX A,	Fragments.	
6.	Interval,	70′	
7.	Limestone VI,	12′	

This group does not occur on the Waynesburg axis or eastward. It is confined to so much of the Nineveh and Waynesburg synclinals as lies within Greene county, and, in the northern portion of the county, it does not cross the Pinhook axis, which separates the two troughs. But in the southern portion of the county, within a mile of the West Virginia line, it does cross that axis; for at a little distance west from the village of Jolleytown, on Dunkard creek, and almost on the crest of the axis the following section was obtained:

1.	*Dunkard coal bed*,	1′ 3″
2.	Limestone IX B,	2′
3.	Shale,	25′
4.	Limestone IX A,	1′ 6″
5.	Interval,	30′
6.	Limestone VI,	3′

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As one would expect the interval between limestone IX a and limestone VI is very much less here than it is nearer the central line of the trough.

Since this little group is confined to the Nineveh and Waynesburg synclinals and for the most part to the middle of those troughs, *the anticlinals must have existed prior to the formation of the rocks included in that group;* and since the group crosses the Pinhook axis at the southern edge of the county, while elsewhere it is wanting on and near the crest of that axis, *the anticlinal must have had the same character then as now—with its elevation low at the south, but increasing northward.*

An equally interesting case of intercalation occurs in the Blairsville trough between the *Redstone* and *Pittsburg coal beds.* On the National road the interval between these beds is barely 50 feet; the Redstone limestone lies almost immediately below its *coal bed* and the rest of the interval to the *Pittsburg coal bed* is occupied by sandy shale. At somewhat more than three miles north from that road, the two *coal beds* are well exposed near Lemont furnace, where the *Pittsburg* is mined for fuel and the Redstone limestone is quarried to be used as flux. At this locality the interval between the coals cannot well be determined without careful instrumental measurement, as the dip is steep and the lines of exposure are in the direction of dip. But the distance between the coals is much greater than on the National road, while the interval between the *Redstone* and the higher *Sewickley* remains almost the same as on that road. On the property of the Dunbar Furnace Company, the exposure is very good and the following section was obtained there:—

1. *Redstone coal bed,*	0′ 10″	
2. Clay,	1′	Interval, 116′
3. Redstone limestone,	10′	
4. Shale,	20′	
5. *Coal bed,*	4′	
6. Clay,	8′	
7. Limestone,	2′	
8. Shale,	25′	
9. *Coal bed,*	1′	
10. Sandstone and shale,	50′	
11. *Pittsburg coal bed,*	16′	

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This increased interval between the *Pittsburg* and *Redstone coal beds* diminishes slowly and irregularly northward to the Pennsylvania Railroad. But northward from that railroad the diminution is rapid, the interval becoming only 50 feet within a couple of miles and finally disappearing within a short distance further north.

There seems then to have been a boat shaped synclinal between the *Redstone* and *Pittsburg coal beds*, tapering northward and southward; for the interval is 50 feet on the National road and the same at a short distance north from the Pennsylvania Railroad, while between the two points, it is at one locality 116 feet. Where the interval is greatest, as in North Union and Dunbar townships of Fayette county, it contains two *coal beds* and one limestone as well as a considerable thickness of shale and sandstone. The *coal beds* and the limestone disappear before reaching Westmoreland county, and there the whole interval is usually filled by sandstone, though occasionally some shale is present.

From these facts, one seems justified in concluding *that soon after the Pittsburg coal bed was formed, there was a well-defined synclinal along this line, which was not filled up until after the formation of the Redstone coal bed.* This basin was bounded by Chestnut ridge and the Saltsburg axis and had the same canoe-shape which characterizes the present Blairsville synclinal.

Distribution of the Limestones.

It would be tedious and hardly profitable to give in detail the comparisons made to determine the distribution of the higher limestones within the districts covered by Reports K, KK, and KKK. It will be sufficient to give a few of the results.

Excepting only the Great limestone of the Upper Productive Coal Series and the Upper Washington limestone of the Upper Barren Series, each limestone of both Series exhibits different characters in the various synclinals, while all of the limestones show a very marked diminution in thickness toward the western, northern, and eastern portions of the

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basin. The area of vastly expanded thickness is in central Washington and the north central portion of Greene county, within the Nineveh, Mansfield, and West Middletown synclinals.

The Upper Washington Limestone has the same features, or nearly so, in all the synclinals, except that it shows eccentric variations in thickness. The Great limestone, lower division, alone of all, seems in respect both of composition and thickness to be independent of the troughs throughout the greater portion of southwest Pennsylvania, and exhibits great regularity at all exposures between the Monongahela and the Ohio, having a maximum thickness of 90 feet on the former river, and of 70 feet on the latter; while at Washington, nearly midway between the two rivers, it shows a thickness somewhat greater than that observed at the Monongahela. A line, joining Wheeling, Washington, and the village of Greenfield, on the Monongahela, marks the area of the greatest thickness. Northward from this line the rock changes in character, becomes less and less calcareous, and in most of the troughs disappears before the final outcrop of its horizon is reached. In Ohio, beyond the western extremity of the line, it steadily diminishes in thickness, and disappears at only a few miles west from the river. In like manner, beyond the eastern extremity of the line, it diminishes, and finally disappears before the Allegheny mountains are reached.

Of the other limestones, the Redstone and Fishpot are found in some synclinals, while they are absent from others. It seems probable, therefore, that the synclinals existed at the time these limestones were forming; but the character and deportment of the Great limestone seem to show quite as clearly that, when that rock was forming, the synclinals had been obliterated.

The limestones between the Great and the Upper Washington show variations very like those of the Redstone and Fishpot, being present in some and absent from others of the synclinals, or being thick in one trough and very thin in the next, or pure in one trough, impure in the next but pure again in the third. When the Upper Washington

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limestone is reached, the conditions seem once more to be such as existed during the formation of the Great limestone, for this bed is present in all the troughs and, though varying in thickness, preserves its typical character throughout.

But, in all cases, the limestones have a decided tendency to become thinner toward the borders of the basin, gradually blending into shale in all directions except the west, where they merely thin out.

These variations lead me to the following conclusions:

That the synclinal troughs were in existence at an early date, and that the lines of the anticlinals were marked either by low ridges of dry land or by shallows.

That then, as now, the whole region was upraised toward the north, causing shallow water and shore deposits, for the limestones give way to shales and these in turn to sandstones in that direction.

That an elevation existed at the west side of the Great Basin, but that it was low and with insignificant drainage, for in that direction the limestones merely thin out, not giving way to sandstones or shales.

That Chestnut Ridge and the axes east from that must have existed in some form or other as early as the time of the Great limestone, for that rock breaks up on the west side of Chestnut Ridge, is utterly insignificant in the Ligonier Valley and disappears finally before reaching the west base of the Allegheny Mountains.

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Chapter XXI.

Structure of Coal Beds.

In all probability, no coal bed, more than one foot thick, fails to show one or more distinct partings. These may be mere knife-edges of black clay, or thicker layers of bony coal; or they may be soft fireclay, from one inch to two or three feet thick; or they may be composed of sandstone. Any one of the many beds, of which detailed measurements are given in this and my previous reports, illustrates this truth, and every geologist, at all acquainted with the coal-field, will at once recall to mind the structure of other beds, which equally confirm the statement. These partings mark so to speak, crises in the formation of the beds, for they are persistent over immense areas. In the *Pittsburg coal bed*, the two little slates, which enclose the "bearing-in" bench, are persistent west from the Saltsburg axis almost to the west outcrop of the bed. Yet they seldom are more than half an inch thick and the included bench is rarely more than four inches. The partings of the *Waynesburg* are equally persistent, as are those of the *Jolleytown*, *Washington*, *Uniontown*, *Upper Freeport* and other beds which can be identified over wide areas.

It is sufficiently clear then that a coal-bed, as the term is commonly used, is not simple, but that it is made up of two or more benches with varying intervals between them. These subordinate beds are as certainly distinct strata as if the intervening rock were 100 feet, instead of one-eighth of an inch thick, for the separating stratum is persistent over thousands of square miles.

Geologists everywhere recognize the fact that strata of all kinds exhibit variations in thickness; thus the Devonian rocks of the middle Appalachian region have a thickness of about 8,000 feet, according to Mr. Ashburner, but they

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thin out to mere feather-edges along the shore of the old Cincinnati Arch; and the whole mass of the Paleozoic is not much more than 5,000 feet thick in the Mississippi valley. Such variations in the great masses would lead one to look for variations in the strata, as well as in the layers of which they are composed; and it would not be unreasonable to expect great variations of thickness in coal-beds or even in their partings. The more so since the *Pittsburg coal bed*, which is 15 feet thick in the Allegheny region, becomes only one foot thick in central Ohio. And the partings do vary. The *Washington coal bed* illustrates this well in the numerous cuts of the Hempfield railroad in Washington county of Pennsylvania. The details of these sections are given in the descriptions of Canton, Buffalo and Donegal townships of Washington county in Report K (1875). They are grouped in Figure 2 of Plate I of this report (KKK).

In Greene county of Pennsylvania, the *Uniontown coal bed* is always double and the benches are separated usually by a thin layer of black clay; but at one locality they are parted by ten feet of rock. In the same county the *Sewickley coal bed* is compound, consisting of several distinct benches separated by thin partings, which, on Whiteley creek, show very positive variations in thickness, while the total amount of coal in the bed remains almost accurately the same. The following measurements show the bed at two localities, five miles apart. The identity of the bed at the two places was proved by direct tracing:

1. *Coal*,	2′ 6″	*Coal*,	2′ 3″
2. Sandstone,	15′ 0″	Clay,	0′ 1″
3. *Coal*,	0′ 5″	*Coal*,	0′ 4″
4. Shale,	2′ 0″	Clay,	0′ 2″
5. *Coal*,	0′ 1″	*Coal*,	0′ 2″
6. Sandstone,	12′ 0″	Parting.	. . . . .
7. *Coal*,	1′ 6″	*Coal*,	2′ 4″
Total,	33′ 6″		5′ 3″

This variation is shown on Figure 1 of Plate I, of this report.

The remarkable variations of the *Upper Freeport coal*

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Fig. 1.

Sections showing the increase in the thickness of the partings of the Sewickley Coal Bed on Whitley Creek in Monongahela Tp. Greene Co. by J. J. Stevenson.

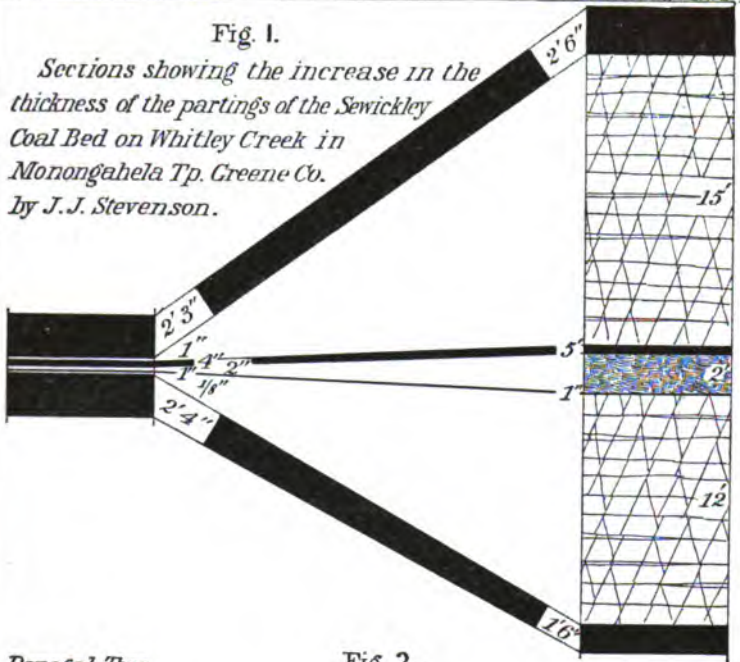
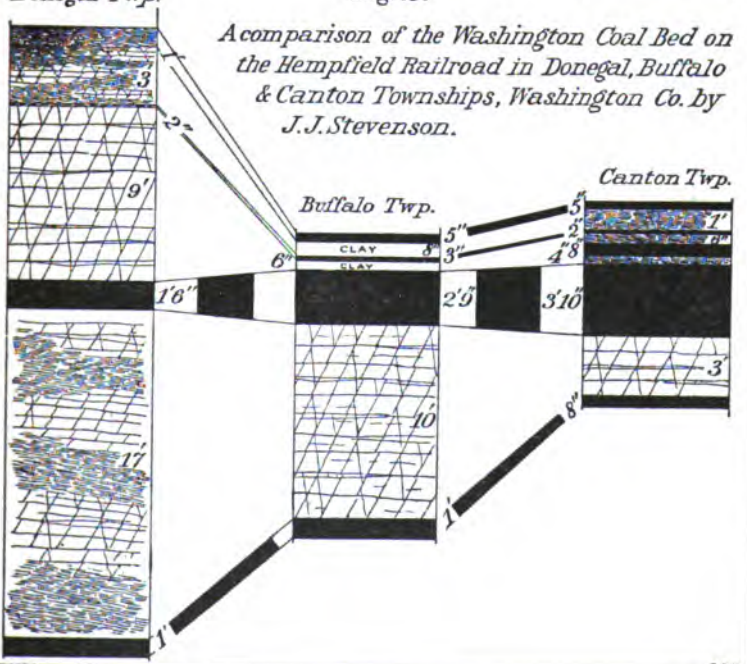


Fig. 2.

A comparison of the Washington Coal Bed on the Hempfield Railroad in Donegal, Buffalo & Canton Townships, Washington Co. by J. J. Stevenson.



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bed in West Virginia were described in Chapter VIII of Report KK. Similar changes occur in the *Jolleytown coal bed* on the Hempfield Railroad in Washington county of Pennsylvania and in the *Coalburg bed* on the great Kanawha river of West Virginia. At the extreme southern point of the Salisbury Basin within Pennsylvania the *Pittsburg coal bed* has a roof coal, separated from it by one foot of clay, but at four miles away the two *coals* are separated by 18 feet of shale, the divergence being gradual. Instances of the same character are by no means wanting in the anthracite region of Pennsylvania. The report on the Girard estate made to the Directors of the City Trusts of Philadelphia in the early part of 1876, gives sections of the *Buck Mountain* and the *Mammoth* veins as they appear at different collieries on the College property. Four measurements of the former show thicknesses of 12 ft. 1 in., 15 ft., 20 ft. 6 in., and 24 ft. 2 in.; while the thickness of the partings breaking up the bed varies thus: 2 ft., 2 ft. 10 in., 5 ft. 4 in., and 11 ft. 6 in.; while the second parting varies from 2 inches to 8 feet. Four measurements of the *Mammoth* vein are given which show it vary thus: 24 ft., 29 ft. 2 in., 34 ft., 49 ft. 6 in., and the thickness of the partings in the several sections varies thus: 1 ft. 10 in., 5 ft. 2 in., 4 ft. 7 in., 16 ft. 9 in.

The *Mammoth* vein shows much greater variations than these. Many years ago, Prof. H. D. Rogers asserted that this bed actually breaks up into several beds separated by wide intervals. At that time, however, the mining operations were not sufficiently extensive to yield indisputable proof of the statement in a country so disturbed as the anthracite region. But the numerous shafts sunk during late years in close proximity to each other have supplied the necessary evidence, as may be seen by reference to the sections on plate III, for which I am indebted to Prof. Robert Frazer, Jr., of Ashland, Penn. With reference to these, Prof. Frazer makes the following statement in his letter accompanying the sections:

"The *Mammoth* vein at Shenandoah is of unusual size, running from 30 to 60 feet thickness. About one half mile

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east from the town a wedge of slate enters the vein, dividing it into two distinct seams, of which the upper is the larger. Still further east the upper seam again separates into two, the lower one being the smaller. The three seams are then known as the top, the middle and the bottom splits of the *Mammoth* vein. In the neighborhood of Mahanoy City they are worked on the lands of the Delano Land Company under the names of the *Mammoth*, *Four-feet* and *Ten-feet* veins. The rock that occurs between these splits is mainly slate, varying through different degrees of grittiness to fine gray sandstone, and so far as my observation extends it is peculiar to the *Mammoth* vein that the rock splitting a vein should be anything but slate. As to the coal itself, the top and bottom splits are the best, the middle split being but little worked at present.

The *Mammoth* vein [acts] in this way at both the eastern and the western end of the Mahanoy Valley, in such a manner that the middle coal-field can be divided into three nearly equal sections, in the central of which the *Mammoth* vein exists entire, while in the eastern section it is worked as three and in the western as two distinct veins, known as the 'twin veins.'

"These *Twin* veins are very unreliable and are in quality constantly interchanging, and it therefore becomes frequently profitable to drive cross-cuts from one to the other and back again as the quality of the seams changes. Fortunately the thickness of the slate is never great. At the Black Diamond colliery near Mt. Carmel, the slates increase from 2 feet to 15 feet in 200 feet. At the Brady colliery near Shamokin, they thicken from 8 feet to 33 feet in one half mile.

"These are the two instances of bifurcation in coal seams, which from their extent have acquired the most importance, but it must not be inferred that they stand alone. On the contrary, there are many instances of such to a less degree, and these are commonly though inaccurately called 'faults.'

"In faulty districts the thickness and even the number of benches of slate in a seam vary greatly. Sometimes they will disappear, and sometimes within a short distance they

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will cut out the coal almost entirely, leaving only a few thin seams to mark where the vein before had been. I have known as much as 500 yards of what was scarcely better than so much tunnel to be driven through this formation without success. In this case the seam was split into at least three different leaders, each of which was followed for some distance in the hope that it might widen into a seam of workable coal. In this way the identification of any particular seam becomes at times very difficult, even when the greatest care be observed and the fullest data be obtained. In the district of Shenandoah, just under consideration, the total thickness of measures between the top of the *Mammoth* and the bottom of the *Buck Mountain* increases in the distance of three and one-half miles from 170 to 410 feet, and the number of seams of coal between the *Mammoth* and the *Buck Mountain* increases from two to four, this being accounted for by the separation of the *Mammoth*."

Now let us examine these sections. In the first there is a coal-bed broken by numerous thin slates, the whole aggregating 33 feet 2 inches; in the second, the bed is broken by a wedge of shale, somewhat more than 10 feet 6 inches thick, this being clearly a thickened parting; in the third, a thin wedge of sandstone is inserted in the upper division of the second, while the wedge of slate has increased to somewhat more than 25 feet; in the fourth, the upper wedge has become 10 feet, and the lower one, 48 feet 6 inches; while in the fifth, the two wedges have become 70 and 30 feet, respectively. Here, then, is a fine illustration of thickening of partings, whereby the bed increases from 33 feet to 130 feet within barely three miles and a half.

Instances equally remarkable with any that have been mentioned have been observed in the coal-fields of Great Britain. According to Greenough, the second and third coal seams of the Ashby de la Zouche coal-field form but one seam in the Bedworth collieries. Half a mile east, the interval becomes 52 feet; followed still further east, it is found to be 75 feet; and in the easternmost colliery of all, it is 99 feet. In Vol. IV, Old Series, of the transactions of

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the London Geological Society, Mr. Winch has given some very remarkable sections showing variations in the Newcastle coal-field.

In the South Staffordshire coal-field, the divisions of the coal-beds are very handsomely shown, and Mr. Jukes gives some excellent illustrations in his memoir on that field. The most important bed is one resembling the *Mammoth* of our anthracite region, in respect both of its numerous benches and of its extraordinary thickness. A typical section of the bed shows that it contains 36 feet 6 inches of coal, with 2 feet 11 inches of refuse material. The various benches are so characteristic that any old miner can at once determine the place of a fragment. The top of this bed is usually known as the *White coal*, and at varying distances above it is another bed called the *Flying reed coal.* At some localities, the *Flying reed* is the *Roof coal*, since there it rests directly on the *White coal*, or at most is separated from it by but a few inches of clay. The following table of measurements was obtained within a distance of one mile along a line following a rudely east and west direction:

Flying reed coal, . .	4′ 0″	4′ 0″	4′ 8″	4′ 4″	3′ 0″
Interval, ...	0′ 0″	10′ 6″	45′ 9″	55′ 4″	128′ 0″
Thick coal, ...	29′ 4″	25′ 4″	26′ 2″	24′ 3″	22′ 8″

In the last section the interval contains 51 feet of sandstone. In another series of sections following a northern line, the interval is found increasing still more rapidly, so that it is from 2 to 3 feet near Dudley, 84 feet near Cosely, and 204 feet near Billston. In the last, the interval contains much sandstone. On the northwestern side of the same field, the *Thick coal* shows a tendency to split much further, which tendency is gratified to such an extent that that bed, which at Billston, is for all practical purposes a single bed, becomes at the northern portion of the district, *nine* coal beds, which, with the intervals separating them, occupy a vertical space of 405 feet.

Mr. Jukes gives some equally interesting details respect-

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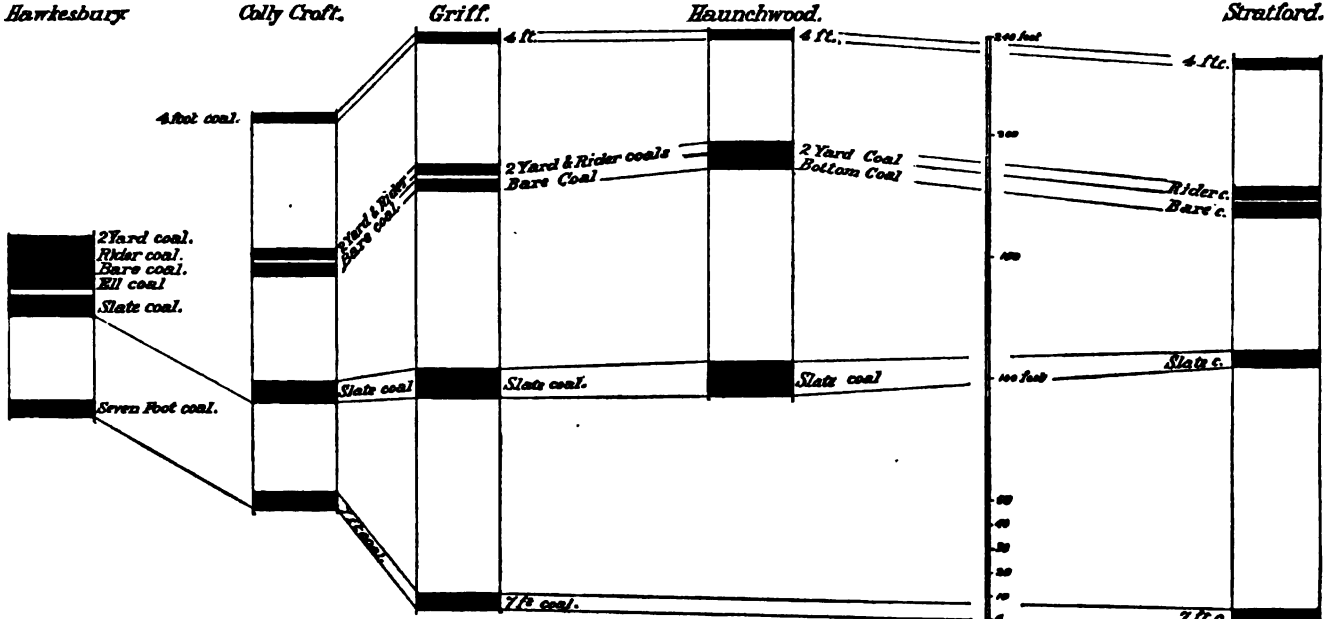
A group of Vertical Sections of English Coal Measures to illustrate the divergence of coal beds.



ing the *Bottom coal bed*, which is one of the thickest in the series. In the southern portion of the field this bed is only double, the benches being separated by *one foot* of clay, but followed northward it is found to become triple and the sum of the rocks separating the divisions finally becomes *52 feet 5 inches*.

In the memoir on the Warwickshire coal-field of Great Britain, Mr. Howell found a similar condition. He says:

"In the southern part of the coal field, in the neighborhood of Bedworth and Hawksbury, the whole of the coals come together and form one thick seam with thin partings of fireclay, whereas in the northern part, in the neighborhood of Tamworth, Polesworth and Baddesley, the same beds of coal are widely separated, the intervening strata of sandstones and shales having gradually thickened out. This gradual separation of the coals by the thickening out of the intervening strata will be understood by comparing the pit sections of the coal-field from north to south, as given in the vertical sections, sheet No. 21."

He illustrates the conditions by a comparative section which is reproduced on Plate II.

In all the instances thus far given, the bifurcation of the beds is clearly shown; but had erosion been a little more energetic at the critical localities, there would have been left only a number of separate beds. The question of bifurcation of coal seams is intimately connected, therefore, with that of variation in the intervals between the coal beds. It is well to look at this matter for a little.

Variations in Intervals between Coal Beds.

The first series of measurements to illustrate these I take from the western side of the Great Bituminous Trough. The line of section begins in Harrison county of Ohio, passes through Cadiz and Georgetown of that county, through Smithfield of Jefferson and Bridgeport of Belmont county. The table shows only the variations of the interval between the *Pittsburg coal bed* and a higher bed known as *coal IX*.

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Coal, IX, ...	. . .	. . .	. . .	. . .	. . .
Interval, ...	7′	24′	31′	83′	155′
Pittsburg coal bed, VIII, ...	. . .	. . .	. . .	. . .	. . .

The characteristic rock in all these sections is a limestone, which in the several sections shows a regular increase, being 5, 20, 25, 45, and 70 feet. It is traceable with the utmost ease and the little double *coal bed*, IX, rests almost directly upon it all the way, until within three miles of Bridgeport. But along this line there have disappeared not only the greater part of this limestone, but also three small coal beds representing the *Sewickley* and *Redstone* of Pennsylvania, together with two imposing beds of limestone. In the fifth section, these limestones are respectively 30 and 25 feet; in the fourth, they are 10 and 8 feet; while in the third, they, with their coals, have disappeared. This series does not show the coals VIII and IX actually united, but one's credulity is but lightly taxed, when asked to believe that since the interval has been reduced from 155 feet to 7 feet by a gradual and constant change, the diminution will continue until the intervening limestone disappears and permits the two beds to come together. The more so, since along this very line the successive disappearance of similar intervals is finely shown.

Another series of sections also from Ohio and following an irregularly east of north course, shows this process with all needed clearness. The measurements are as follows:

Coal X, ...	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Interval, sandstone, ...	40′	50′	. . .	. . .	60′	60′	30′
Coal IX, ...	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Interval, limestone, ...	70′	64′	43′	45′	6′	0′	0′
Coal VIII, C, ...	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Interval, sandstone, ...	25	20′	18′	20′	8′	0′	0′
Coal VIII, B, ...	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Interval, limestone, ...	30′	15′	15′	8′	0′	0′	0′
Coal VIII, A, ...	. . .	. . .	. . .	. . .	. . .	. . .	. . .
Interval, limestone, &c., . .	25′	30′	15′	10′	6′	0′	0′
Coal VIII, ...	. . .	. . .	. . .	. . .	. . .	. . .	. . .

The seventh section, obtained by the late Prof. Henry Newton, is of special interest in that it shows *coal XI* at only 75 feet above *coal X*, whereas in No. 1, taken on the

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Central Ohio Railroad, the interval between those coals is somewhat more than 100 feet. In all of these sections *coal IX* is wanting, as it thins out eastwardly and disappears at a short distance west from the line of section.

Here we have a gradual approximation of these beds, the interval of 190 feet becoming at last only 30 feet, while the intermediate intervals have successively disappeared. It is worthy of note that the coal beds VII a and c show no change in thickness. They are both thin and in the sections vary from 6 to 12 inches, the latter being the thickness of VIIIc at the last exposure along the line of section. VIIIb disappears at once, having been seen only on the railroad. It is a split from VIIc or the *Sewickley*, as is well shown in sections along the Ohio river between Benwood and Wheeling.

From details gathered during the past three years in Greene, Washington, Fayette, Westmoreland, and Allegheny counties of Pennsylvania, I have made up six sets of measurements for the Washington group of the Upper Barren Series, and six similar sets for the Upper Productive Coal Series, in order to show the variations in intervals, as exhibited in the several synclinals within those counties. To save space, the sections are not given in detail, and I have taken only the thickness of the groups. Thus, in the first table the measurements represent the interval between the Upper Washington limestone and the *Waynesburg coal bed*, while in the second the distance between the *Waynesburg coal bed* and the *Pittsburg coal bed* is indicated. The order of the synclinals is from the west toward the east, and that of the measurements from the south toward the north.

TABLE I.

Washington Group of the Upper Barren Series.

1. West Middletown Synclinal.
    1. Buffalo Cr. Wash. Co., ... 265′
    2. Cross Cr. Wash. Co., ... 245′
    3. West Raccoon Cr., Wash. Co., ... 165′
2. Mansfield Synclinal.
    1. Hunter's Fork of S. Wheeling Cr., ... 275′
    2. Canton T. of Wash. Co., ... 245′

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3. Ninevah Synclinal.
   1. South Wheeling Cr., Greene Co., ... 335′
   2. Washington, Wash. Co., ... 270′
   3. S. Strabane T., Wash. Co., ... 242′
4. Waynesburg Synclinal.
   1. Dunkard Cr., Wayne T., Greene Co., ... 500′
   2. Waynesburg, Greene Co., ... 440′
   3. Zollarsville, Wash. Co., ... 320′
   4. Hillsborough, Wash. Co., ... 275′
5. Lisbon Synclinal.
   1. Jefferson T., Greene Co., ... 310′
   2. Rostraver T., Westmoreland Co., ... 235′
6. Blairsville Synclinal.
   The group is not fully exposed in this trough.

TABLE II.

The Upper Productive Coal Series.

1. West Middletown Synclinal.
   1. Wheeling Cr., West Virginia, ... 260′
   2. Cross Cr., Wash. Co., ... 235′
   3. East Raccoon Cr., Wash. Co., ... 190′
   4. West Raccoon Cr., Wash. Co., ... 175′
   5. Eldersville, Wash. Co., ... 156′
2. Mansfield Synclinal.
   No full measurement can be obtained here.
3. Ninevah Synclinal.
   1. Belton, West Virginia, ... 400′
   2. Washington, Wash. Co., ... 274′
   3. Peter's Cr., Wash. Co., ... 235′
4. Waynesburg Synclinal.
   1. Saw-mill Run, Wash. Co., ... 314′
   2. Monongahela City, Wash. Co., ... 298′
5. Lisbon Synclinal.
   1. Dunkard Cr., Greene Co., ... 380′
   2. Mouth of Ten-mile Cr., Greene Co., ... 357′
   3. Brownsville, Fayette Co., ... 345′
   4. Rostraver T., Westmoreland Co., ... 250′
   5. North Huntingdon T., Westmoreland Co., . . 210′
6. Blairsville Synclinal.
   1. Georges T., Fayette Co., ... 325′
   2. South Union T., Fayette Co., ... 320′
   3. North Union T., Fayette Co., ... 310′
   4. Dunbar T., Fayette Co., ... 380′
   5. Unity T., Westmoreland Co., ... 280′
   6. Derry T., Westmoreland Co., ... 160′

No measurements are given from the Ligonier Valley or the Salisbury basin, because the section is not complete in those troughs, and in addition, the identification of the

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beds above the *Pittsburg* cannot be accepted with full confidence, owing to the distance from other troughs in which the Upper Coal Series is fully shown.

In preparing these tables, I have changed the limits of the groups, so that the Washington group rests directly on the *Waynesburg coal bed*, a most unmistakable horizon. The section of the Washington group, as given in Reports K and KK, shows how difficult it would be to err in the identifications, especially since the *Jolleytown*, *Washington* and *Waynesburg A coal beds* are persistent, as are also the Limestones IA, II and VI, while the other limestones are present throughout some of the synclinals though absent in others. In the Upper Productive Coal Series, error is quite as difficult, since in all the western troughs, the *Waynesburg*, *Uniontown* and *Pittsburg coal beds* are present throughout, while the Great limestone is fully exposed in all the measurements given. In the eastern two synclinals, the *Waynesburg*, *Uniontown*, *Sewickley*, *Redstone* and *Pittsburg coal beds* are persistent to the central line of Westmoreland county, and the Waynesburg and Great limestones are persistent to the same line. These are guides, which render error almost impossible, unless gross negligence be exercised. Details of these measurements may be found in the township descriptions contained in my several reports. These detailed measurements prove that all the intervals between the coal beds decrease in the same direction with the series itself and that they are all wedge-shaped. The exceptional variation in the Blairsville trough has been fully explained in the Chapter on the Age of the Axes.

By reference to the maps it will be seen that, in several of the troughs, the sections stop far short of the northern limit of the Upper Coals. Owing to erosion, the upper part of the section is wanting for a long distance south from the final outcrop of the *Pittsburg coal bed.* I have preferred to give no partial sections, desiring to bring this discussion within as small space as possible. In like manner no measurements have been given respecting which there was any room for doubt. In the Lisbon trough, the interval between the *Pittsburg* and *Waynesburg beds* at the extreme

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northern exposure, beyond the Conemaugh, seems to be little more than 100 feet; but this measurement is not included, because at the time this report is prepared, the connection of the section has not been fully made out. Partial sections without number might be given to show that north from the last section in several of the troughs, the subordinate intervals thin out more rapidly than they do south from the line of that section.

If we compare these measurements with those obtained in eastern Ohio, we shall find that in each trough the intervals thin out northwardly, and in addition that they diminish quite regularly along a northwest line beginning with the Lisbon trough. Even on an almost west line the changes are sufficiently marked, being, Brownsville, 345 feet; Washington, 274 feet; Cross creek, 235 feet; Smithfield, Ohio, 220 feet. The same condition will be found in the opposite direction, or east from the Lisbon trough, though here our information is necessarily imperfect, as the sections east from Chestnut ridge are incomplete. We may take that portion extending from the *Pittsburg* to the *Uniontown coal bed*, and we find the interval at Brownsville, 241 feet; at Uniontown, 230 feet; at Meyersdale, in the Salisbury basin, 160 feet.

It is very evident therefore that in the great trough west from the Allegheny mountains the Upper Productive Coal Series shows a regular thinning out northward in all the synclinals, as well as both eastward and westward from the Lisbon trough. Within Pennsylvania this applies equally to the Upper Barrens; what may be the condition in West Virginia and southeastern Ohio has not been ascertained.

Examination of the many sections of the Upper Barren Series, given in the report for 1875, and those of the Upper Productive Coal Series, contained in all of my reports, shows that the thinning out of those groups is similar in mode to the thinning out of intervals between splits of coal beds in England and in the anthracite region of our own country, so that it seems not wholly improbable that, had the borders of the field escaped erosion, all the coal beds of the series would have been found to be merely splits from

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the *Pittsburg*, the only bed which is persistent at all localities where its horizon is exposed—persistent, not only in presence, but also in thickness, since its variations are within narrow limits, or at least occur with a certain degree of regularity.

This variation of thickness in coal groups is not confined to the northern portion of the great trough or to the upper two series. The interval between the *Upper Freeport* and the *Brookville coal beds*, the highest and the lowest bed of the Lower Productive Coal Series, increases southwardly from barely 150 feet in southwest Pennsylvania to fully 900 feet on the Great Kanawha river of West Virginia; while the interval between the latter bed, resting almost directly on the Pottsville Conglomerate, and the first of the Sharon Coal Group, lying immediately below that conglomerate, increases in the same direction from about 80 feet in southwest Pennsylvania to fully 1300 feet on the Great Kanawha. In the first volume of the Kentucky reports, Dr. D. D. Owen states that in the central portion of the eastern coalfield of that State, the coal beds show a remarkable parallelism, but that as they approach the eastern border, there is an equally remarkable decrease of the intervals between them. Prof. R. Frazer has shown similar variations in the anthracite region. On page 85 of the memoir on the South Staffordshire coal-field, Prof. Jukes shows that this condition of regular decrease in interval exists there, for in going northward the distance between the *Blue Flats coal* and the *Thick coal* increases with great regularity from 240 feet to 395 feet, while the interval from the *Thick coal* to the *Bottom coal* increases in the same direction from 133 feet to 291 feet; thus showing that the interval of 373 feet at the southern end of the field becomes 686 feet at the northern end.

Troubles in Coal Beds.

These are known to the miners as faults, dykes, clay-veins, mudseams, horsebacks, rolls, and swamps. No true faults or dykes occur in the coal beds of southwest Pennsylvania, west from Laurel ridge, but clay-veins or mud-

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seams are frequently referred to under those names. These are streaks of clay or slate, which vary much in width and direction and pass through the coal from bottom to top, frequently involving also the overlying rocks. Horsebacks are irregular masses of clay or sandstone, coming down from the roof and cutting out a greater or less thickness of the coal; while rolls are simply swells of the underclay, cutting out the lower portion of the bed. Swamps are irregularities of the dip, which interfere seriously with mining operations.

Clay-veins. These are found in most of the beds, but the extensive mines in the *Pittsburg* afford the best opportunities for discovering and examining them, so that they are usually supposed to occur more frequently in that than in the other beds of the series. Extensive clay-veins were seen in the *Redstone*, *Waynesburg* and *Washington coal beds*, but little could be ascertained respecting them as the mines, in which they were observed, are for the most part insignificant and affords no chance for extended tracing.

Two classes of clay-veins were found; one distorts the coal and curls or twists it on one or both sides so as to make it worthless, while the other simply passes across the bed and seems to have little or no effect on the coal on either side.

Veins of the First Class. These invariably injure the coal. An excellent typical example of this class, seen in northwest Westmoreland county, is described on p. 369 of Report KK. In the main entry of the pit, this vein has caused a serious faulting of the coal, but the fault, though amounting to fully 3 feet, involves only a small portion of the bed, for at a few yards further in the entry, the bottom of the bed occurs in its proper place as though no faulting had occurred. On each side for a considerable distance, the coal is curled and is as tough as limestone, its structure being wholly destroyed, as though it had been crushed to powder and afterwards re-consolidated. The curling does not shade away into the good coal, but ends abruptly and the line of junction is approximately parallel to the ziczag course of the vein. This vein extends into the overlying rocks.

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A curious clay-vein was seen near Buena Vista in Elizabeth township of Allegheny county. It faults the coal nearly 10 inches. At the base it is a broad roll of the underclay, but it soon narrows and passes almost vertically through the coal, throwing off a branch on each side as it enters the main clay parting and again as it goes through the roof division. It spreads out for a little way on top of the bed, but does not enter the overlying shale. On a run entering the Monongahela river at Elizabeth in the same township one was seen at the works of Woods, Strader & Co., which has faulted the bed nearly 5 feet. At 3 yards from where the main vein leaves the roof coal to enter the overlying rock, a spar passes downward through the coal. The underclay swells so as to lift the coal at one side of the fault and some of the bed seems to have been cut away at the other. Curling extends for three yards on one side of the vein.

In Penn township of Westmoreland county, as described on p. 332 of Report KK, two clay-veins were seen, which extend from the underclay to the roof shales, and they are said to have been reached by wells sunk in the rocks above. On each side the coal is badly twisted, and for several yards away the surfaces along the cleavage planes are coated with clay.

Quite a number of clay-veins were observed in the *Pittsburg coal bed* at the extensive mines of the Westmoreland Coal Company, at Irwin, on the Pennsylvania Railroad. These are from 10 to 16 inches wide ; they divide, subdivide, and occasionally re-unite, while sometimes the branches diverge quite materially. None of them has been traced to its disappearance. The more important veins reach from the underclay through the coal bed into the overlying rocks, and in most instances are faulted in entering the main clay parting, so as to be thrown into the roof division at from 2 to 4 feet beyond the place of emergence from the lower division of the bed. When a vein divides, the branches usually have the same vertical extent, and show the same general characters with the main stem. In the vicinity of these veins, the coal loses all structure, and becomes bony,

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but this change is more marked near the smaller veins or branches than it is near the larger ones. In one case, a streak, barely 4 inches wide, twists itself irregularly through the bed, and injures the coal to a distance of several yards on each side, while not far off, in the same entry, one, a foot thick, has produced very much less disturbance. The extent of injury seem to depend in some degree upon the course of the vein, so that one passing directly through the bed is less likely to cause damage than is one following a tortuous course, though the latter be much narrower than the other. As a rule, the smaller veins appear to be much more twisted than the larger ones.

Many other instances of clay-veins have been described in the Reports K and KK, but I cite only two instances from the region west from the Monongahela river.

In a cut on the Panhandle Railroad, just west from Burgettstown in Washington county, the *Pittsburg coal* at one point is but 2 feet thick, while at a few yards away it is 8 feet, and all possible variations between these limits occur in this cut. The bed is sadly injured by swells of the underclay, which cause these great and sudden changes in thickness. Associated with one of these rolls is a clay-vein, which breaks through the coal and enters the overlying rocks, reaching into them for a considerable distance. A similar clay-vein was seen in Robeson township of the same county, which after passing through the coal is quite as well marked in the shale above for fully 20 feet.

Evidently related to clay-veins of this class are many of the wedges of clay which descend from the roof and fill cavities in the coal, reaching sometimes almost to the bottom of the bed. The miners term these razor-blades. In several instances they were found in the overlying shale to a considerable distance above the coal. They always consist of clay. A very curious illustration of these is seen in the so-called horse-backs of the Foster mine at Penn station on the Pennsylvania railroad in Westmoreland county. These cut out whole of the roof division, and under them the coal is as badly curled and twisted as it is alongside of some of the very worst clay-veins.

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Clay-veins of this class always exhibit certain features. The coal is curled on one or both sides; the coal bed is thrown to a greater or less extent; the coal in the walls is always slickensided; and the course of the veins is usually parallel to that of the anticlinal axes. The fissures are filled with clay which is similar to that forming the floor of the coal and in every instance it is the underclay. Occasionally this clay is forced not only through the coal bed but also into the overlying rocks.

In Report K, when describing the clay-vein near Burgettstown, I stated that perhaps these factures in the coal might have resulted from disturbance during the plication of the rocks. This explanation seems to be a very probable one and in every way consistent with the phenomena. Some of the razor-blades originated in this way, for the upper clay has been forced downward into the bed. An excellent illustration of this was seen in the Foster mine at Penn station in Westmoreland county, where, under heavy pressure in a temporarily abandoned portion of the mine, the timbers had partially yielded; the coal had been fractured so as to make a wedge-shaped opening into which the pressure had forced the upper clays.

Veins of the Second Class. These are quite characteristic of the *Redstone coal bed* and are not rare in the *Pittsburg*, but they were seldom seen in the other beds. In several characters they differ much from those of the other class; they do not fault the beds, they do not injure the coal and they pass directly through the bed without suffering any distortion. Frequently they are very wide, replacing the coal for several yards.

I am inclined to think that these mark lines along which streams flowed during the formation of the coal bed. At the same time there are a few instances in the *Pittsburg bed* which seem to render such a conclusion somewhat doubtful. In the Foster mine, to which reference has been made already, there is an enormous clay-vein, displacing the coal for a distance of 5 feet along the entry. On each side the coal is wholly uninjured. But this vein breaks up into a number of branches, which throw the coal and curl

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it as badly as do any clay-veins which have been seen anywhere. It is not impossible, however, that the branches may be of later origin than the main vein itself, for a break in the continuity of the bed, such as one of these washes, would be a line of weakness, which during the folding of the rocks might be acted on so as to cause its extension in the narrow fractures which now seem to be branches of the broad gap.

Horsebacks. These are swells of the roof, which usually displace only the upper portion of the coal, though, in some instances, not only all the coal but also much of the underclay has been removed. They consist of sandstone or shale, being generally of the same composition with the immediately overlying rock. Occasionally, however, the material is different, as is the case with many of the razor-blades in the *Pittsburg coal bed* and some of the broad clay horsebacks in the *Redstone.*

Ordinarily horsebacks seem to have resulted from erosion while the immediately overlying rock was being deposited, and frequently the sandstone contains fragments of the coal; but where the material differs from that of the overlying rock, there is certainly reason to suppose that this is evidence of an erosion begun after the overlying rock had been deposited. The horsebacks have no regular course.

In some instances severe pressure appears to have been exerted during the filling of the excavation. Such a case appears occurs in Redstone township of Fayette, and is described on p. 231 of Report KK.

Swells in the underclay are of frequent occurrence in the *Pittsburg coal bed* throughout the Blairsville trough. They often replace the lower half of the coal bed, and they evidently ante-date the formation of the coal.

Swamps or irregularities of dip occur with certainty near the bottom of the synclinals, but they occur also on the sides of the trough. In Report KK, extensive swamps are described as occurring near Greensburg and Irwin in Westmoreland county, and frequent reference is made to them in the description of the coal works in Fayette county. They undoubtedly owe their origin, in most instances, to

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the disturbance inducing the general folding of the rocks throughout the region.

Are Coal Beds Continuous?

This question naturally suggests itself during the consideration of matters already discussed in this chapter.

The *Pittsburg coal bed* is never wanting at any locality, where its horizon is above water-level, or where it has been reached by boring. This bed has its greatest thickness near the southern line of Pennsylvania, and east from the Monongahela river. In all directions, except directly eastward from this area, it shows a gradual diminution in thickness. Southeastward the decrease is more marked than toward the northwest.

In that portion of the Great Bituminous Trough lying north from the Staunton pike in West Virginia and east from the Ohio river, as well as in Ohio north from the Central Ohio Railroad, the *Waynesburg coal bed* is invariably present wherever its horizon is reached, though it shows strange variations in thickness. No effort has been made to identify the bed south from the limits given. A similar statement is true respecting the *Waynesburg A* and the *Washington coal beds*. With respect to their extent southward no information exists.

The *Redstone* and *Sewickley coal beds* are not constant to such a degree, that one would be justified in expecting to find them in a boring at any distance from the outcrop. Yet within certain limits they are persistent, and it is by no means impossible that at some future time their areas may be mapped out with as much precision as is possible with those of the coals already mentioned. They are absent from extensive districts, yet they are very constant in many large areas, and I cannot resist the conviction, that they do not occur in isolated patches, containing from 100 to 1000 square miles, but that these areas are only parts of one whole and that they are continuous in the sense, that they are connected. The barren areas doubtless represent localities, which offered no opportunity for the accumulation of coal; and this opinion is further strengthened by the varia-

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tions in thickness, which are almost as regular within limited areas as are those of the *Pittsburg*, and much more so than those of the *Waynesburg*.

The evidence is sufficient to justify the conclusion that the *Pittsburg*, *Redstone*, *Sewickley*, *Waynesburg A* and *Washington coal beds* stretched over the northern portion of the trough, and that all, except the second and third, were absolutely continuous over the whole area. Respecting the still higher coals, too little is known to enable one to form a definite opinion. They occur only in Greene county and in small outlying patches in Fayette and Washington counties.

Less certainty prevails respecting the lower coals, but some of the beds belonging to the Lower Productive Series have been followed out so far, that we may speak with some degree of assurance respecting them. At nearly every locality where the horizon is exposed, a coal bed of varying thickness is found at from one to 40 feet below the Mahoning sandstone, accompanied usually by a limestone at a few feet below it. This bed, the *Upper Freeport*, may be regarded as continuous so far as the areas of outcrop on the edge of the trough are concerned, but its distribution in the central portion of the basin is by no means fully ascertained. Borings have been made at no considerable distance from the crop, which failed to find the bed. Yet the same bed is found in the Oil-break of West Virginia, in the very center of the basin, where it has been brought to the surface by the disturbance causing the anticlinal. It is probably continuous like the *Redstone* and *Sewickley*. This is the *coal VI* of the Ohio column, which is so important at so many places in that State.

On the Pottsville Conglomerate, or at a few feet above it, there is found a coal bed at all exposures. In the preceding chapters of this report it has been identified with the *Brookville* and it is the same with the *Mt. Savage (?) coal bed* of Report KK. This bed is persistent in western Pennsylvania and West Virginia, but its relations to the Ohio series has not been fully determined, since the Conglomerate changes to such an extent toward the north that

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the lower portion of the coal series along the Ohio line needs careful revision before the section of the two States can be fully harmonized.* In central Ohio a coal bed rests on a conglomerate, which overlies the Maxville limestone of Prof. Andrews and so it may be the same with this coal. The Maxville limestone is of Chester age, the same with the Mountain limestone of the Umbral. The *Brookville coal bed*, therefore, may be regarded as continuous round the outcrop in the northern part of the trough.

Between these two beds are others which have been recognized at many localities within the outcrop areas and the identifications may be regarded as reasonably certain within Pennsylvania and northern Ohio. But not sufficient information has been published to enable one to speak positively respecting their distribution even in this State, while the relations of these beds to those holding somewhat similar relations in West Virginia are far from being established.

Not one of the coals below the *Upper Freeport* occurs in the oil-break of West Virginia. Were only one or two of the coals missing, there would be no ground for surmise, but since all are wanting along a line of 15 or 20 miles, where the section is exposed several times and where hundreds of borings have been made, it seems highly probable that all the coal beds between the *Upper Freeport* and the Pottsville Conglomerate disappear before reaching the center of the basin, and that they were formed only around the borders of the area, not across the whole.

Of the whole series, the *Pittsburg bed* alone is persistent economically. At no point except along the extreme east and west outcrops in central Ohio and West Virginia, has this bed been found of less than workable thickness. Its variations are so systematic, that any one who has carefully studied the numerous measurements which I have given in reports upon southwest Pennsylvania, on eastern Ohio and in my Notes on the Geology of West Virginia, can calculate its thickness, at almost any locality. Every other bed is sub-

* This work has been performed by Prof. I. C. White, but his results are not yet published.

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ject to so great and so abrupt variations, both in quality and thickness, that boring for it is attended with much risk of loss; and some of the beds may have been simply disconnected swamps, just as we now find immense peat bogs, wholly disconnected and separated by many miles.

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Chapter XXII.

Notes on the Paleontology of Southwest Pennsylvania.

During the seasons of 1875–6–7, only such notes respecting the fossils were taken as could be obtained during a hasty examination of the rocks, and no attempt was made to collect specimens. It is evident, therefore, that the lists appended to this chapter are far from being complete.

Near the village of Jolleytown in Greene county, remains of plants were found abundantly in shales overlying the *Dunkard coal bed;* and the species are of interest, as some of them represent genera previously unknown in our Coal Measures. Near the head of Pursley creek, in Center township of Greene county, leaves of *Sigillaria menardi* are plenty in shales overlying the Upper Washington limestone, but no other parts of the plant were observed. At the tunnel, one mile east from the borough of Washington in Washington county, stems of this plant are abundant in the same shale. The only fern found there was a fragment of *Neuropteris*, which was not sufficient for specific determination.

The irregular shale between the *Waynesburg coal* and the overlying sandstone has yielded excellent specimens of plants both in Greene and Fayette county. The best localities for collecting are on Muddy creek and the Monongahela river in Cumberland township of Greene, and near Brown's run in German township of Fayette; but the specimens from Fayette county are much inferior to those obtained from Muddy creek at Carmichaels. These plants are of interest also because they contain a new flora, which seems to show that the climatic conditions toward the close of the Upper Productive Coal Series were much like those of a later period in Europe.* The shales between the *Red-*

* This information I owe to Prof. I. C. White.

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stone and *Pittsburg coal beds* are plant-bearing near Brownsville and in the northern portion of Nicholson township of Fayette, but the species are few in number. A specimen of *Spirophyton* was found in the Pittsburg sandstone on Dunkard creek, near Bobtown in Greene county. A few plants were obtained from a shale not far below the *Pittsburg coal bed* near Bowerhill station on the Chartiers Valley Railroad in Allegheny county.

The Mahoning sandstone usually contains fine impressions of stems, and occasionally casts occur, but the latter are more common in the lower sandstones. In the Upper Mauch Chunk shale, near Stewarton, on the Pittsburg and Cumberland Railroad, there is a thin layer, which contains many impressions of plants.

These plants are not enumerated in the lists appended to this chapter, as they will be discussed in Prof. Lesquereux's special report.

Animal remains were found more or less abundant in most of the limestones, as well as in some of the shales belonging to the higher series; but thus far the rocks of the Lower Productive Coal Series have proved for the most part quite barren of fossils.

In the limestones of the Upper Barren Series, *ostracoids*, resembling *cypris*, are the prevailing forms, and in some no other remains occur. In the Middle Washington limestone, fish remains were found, and at some localities that bed shows immense numbers of bryozoans on the weathered surface, where they are so defaced by weathering as to be unrecognizable. With these, minute species of *Bellerophon* and *Euomphalus* are frequently associated.

In the shales resting on the Upper and Lower Washington limestones, ostracoids resembling *estheria* are abundant, and are accompanied by minute teeth and scales of fish. In a shale resting on Limestone III, near the western edge of Nottingham township, of Washington county, some large scales of fish belonging to *rhizodus*, were found associated with some undetermined lamellibranchs, probably *Pleurophorus*. The best localities for collecting from these strata are, for the Lower Washington limestone, Waynes-

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burg, on Purman's run; for the Middle and Upper Washington limestones, the cuts on the Hempfield extension, east from Washington; the Nottingham locality is on the Hempfield extension in a deep cut near the western line of that township.

In rocks of the Upper Productive Coal Series, fossils are very rare, and such as do occur are very stunted, as though the conditions were unfavorable to marine life. The massive layers of the Great limestone are almost uniformly barren, while the thinner layers occasionally show some insignificant forms on their weathered surfaces. As these are not silicified, they cannot be determined, and frequently even the genus is uncertain. Near Cannonsburg, on the Chartiers Valley railroad, the lowest layer contains some univalves and lamellibranchs, the latter evidently belonging to *nucula*. Two layers in the upper portion contain small univalves. Near Manor station, on the Pennsylvania railroad, in Westmoreland county, this limestone, which there is very thin and poor, contains many ostracoids, like those found in the limestones of the Upper Barrens. The Redstone and Fishpot limestones are non-fossiliferous. The *Uniontown coal bed* is often represented by a carbonaceous shale, and then it yields great numbers of minute teeth and scales of fish. Aside from these no fossils have been found in rocks of this series within Pennsylvania, though immediately over the border in West Virginia a layer of blue shale above the *Sewickley* was seen containing many specimens of *Solenomya*.

In the Lower Barren Series, every limestone has been found fossiliferous at some locality, but the only rocks persistently so are the Green and Black limestones. The former is widely exposed in Allegheny and Beaver counties, near the Ohio and Monongahela rivers, as well as along the Conemaugh in Westmoreland, and along the base of Chestnut ridge in Westmoreland and Fayette. Good localities for collecting from this limestone are, Thompson's run station on the Pitts., Va. and Charleston RR., Birmingham, opposite Pittsburg, near Harvey's Five Points in Westmoreland county, and near Springhill furnace in Fayette

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county. The Black limestone is even better marked than the other, and excellent localities for the collector are on the Pennsylvania Railroad near Lacolle station, and midway between Carpenter and Stewart stations, both in Westmoreland county. In this rock the specimens are more easily obtained than in the Green limestone, and the best specimens occur in the shale immediately overlying the limestone. Except a few crinoids and corals, the remains obtained from these limestones are all molluscan.

In the sandstone, which is at the base of the section at New Geneva in Nicholson township of Fayette, Dr. Frank Cowan of Greensburg has discovered a great number of markings, many of which are much like foot-prints. Of these he has taken numerous casts in plaster, intending to prepare a full discussion of their relations. The footprints obtained many years ago by Dr. King were found in Derry township of Westmoreland county in a sandstone, which according to the best information attainable, holds a place very near that of the New Geneva sandstone.

In the Lower Coal Series, the Ferriferous limestone is fossiliferous in Beaver county. At some localities the Johnstown Cement bed contains stunted fossils.

As a rule, the Umbral rocks above the Mountain limestone show no fossils, but at Dunbar, in Fayette county, the Big Bottom ore occasionally yields some fossils. Mr. Pechin of Dunbar showed me an *Orthoceras*, a *Pleurotomaria*, and an *Allorisma*, which had been obtained from the ore. The Little Flag ore, at Wharton furnace in the same county, frequently contains fossils.

The Mountain limestone is very rich in fossils, and excellent localities are, Wharton Furnace, Dunbar Furnace, National road, Shute's run and Redstone creek in Fayette county, Jacob's creek, and the Conemaugh gap through Chestnut ridge in Westmoreland county. All of these localities are easily reached, and the fossils are abundant, but the southern localities are the best.

The Pocono sandstone is wholly non-fossiliferous in the river gaps, but on a branch of Georges creek in Fayette county, it contains fish spines and plates, associated with badly preserved univalves, apparently *Pleurotomaria*.

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The Devonian rocks of the river gaps are very rich in species of Chemung fossils, with which occur some species belonging to the upper line of the Hamilton group. The localities for procuring these fossils are quite accessible, being along the lines of the railroads. They are, Conemaugh gap through Chestnut ridge, less than two miles above Blairsville Intersection; Youghiogheny gap through Chestnut ridge at a mile and a quarter below the mouth of Indian creek; the gap of the same river through Laurel ridge at less than two miles above Ohiopyle Falls, being the first rock-cut above the falls, and excellent collections can be made on the National road on Chestnut ridge. At all of these localities the specimens are abundant, and they are as well preserved as Chemung specimens usually are in New York State.

List of Fossils.

1. Coal Measures.

1. *Crinoidal fragments.*
2. *Erisocrinus*, undt. sp.
3. *Zeacrinus mucrospinus*, McC.
4. *Lophophyllum proliferum*, McC.
5. *Lingula* sp.
6. *Hemipronites crassus*, M. & H.
7. *Meekella striato-costata*, Cox.
8. *Chonetes granulifera*, Owen.
9. *Chonetes Smithii*, N. & P.
10. *Productus Nebrascensis*, Owen.
11. *Productus Prattenianus*, N.
12. *Productus longispinus*, Sow.
13. *Productus pertenuis*, Meek?
14. *Orthis Pecosii*, Marcou.=*Orthis carbonaria*, Swallow.
15. *Athyris subtilita*, Hall.
16. *Spirifer lineatus*, Martin.
17. *Spirifer plano-convexus*, Shum.
18. *Spirifer Rocky-montani*, Marcou.=*Spirifer Opimus*, Hall.
19. *Spirifer cameratus*, Morton.
20. *Aviculopecten carbonarius*, Stevens.

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21. *Aviculopecten rectilateraria*, Cox?
22. *Aviculopecten Hertzeri*, Meek,
23. *Lima retifera*, Shum.
24. *Myalina subquadrata*, Shum.
25. *Nucula parva*, McC.
26. *Nucula anodontoides*, Meek.
27. *Nucula*, Sp.
28. *Nuculana bellistriata*, Stevens.
29. *Yoldia Knoxensis*, McC.
30. *Yoldia Stevensoni*, Meek.
31. *Astartella concentrica*, Con.
32. *Astartella vera*, Hall.
33. *Astartella*, Sp.
34. *Pleurophorus*, Sp.
35. *Macrocheilus primigenius*, Con.
36. *Polyphemopsis peracutus*, M. & W.
37. *Euomphalus subrugosus*, M. & W.
38. *Euomphalus*, Sp.
39. *Bellerophon carbonarius*, Cox.
40. *Bellerophon percarinatus*, Con.
41. *Bellerophon Montfortianus*, N. & P.
42. *Bellerophon*, Sp.
43. *Pleurotomaria carbonaria*, N. & P.
44. *Pleurotomaria tabulata*, Con.
45. *Pleurotomaria conoides*, M. & W.
46. *Pleurotomaria Grayvilliensis*, N. & P.
47. *Pleurotomaria turbiniformis*, M. & W.
48. *Pleurotomaria*, Sp.
49. *Orthoceras Rushensis*, McC.
50. *Nautilus occidentalis*, Swal.
51. *Estheria*, Sp.
52. Undt., ostracoids.
53. Undt., teeth and scales on fish.
54. *Rhizodus*, Sp.
55. *Ctenacanthus Marshii*, N. & W.

II. *Lower Carboniferous.*

1. *Monticulipora*, Sp.
2. Crinoidal columns.

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3. *Zaphrentis spinosus*, Hall.
4. *Hemipronites crassus*, M. & W.
5. *Productus elegans*, Sow.
6. *Productus cora*, Var.—*Pileatus*, McC.
7. *Athyris subquadrata*, Hall.
8. *Spirifer Leidyi*, N. & P.
9. *Aviculopecten occidentalis*, Shum.
10. *Pinna Missouriensis*, Swal.
11. *Myalina*, Sp.
12. *Allorisma Clavata*, McC.
13 to 16. *Allorisma*, Undet.
17. *Allorisma terminalis*, Hall.
18. *Macrocheilus*, Undt.
19 to 21. *Bellerophon*, Undt.
22. *Bellerophon crassus*, M. & W.
23. *Pleurotomaria*, Undt.
24. *Straparollus planidorsatus*, M. & W.
25. *Orthoceras*, Undt.
26. *Cyrtoceras*, Undt.
26. *Phillipsia Stevensoni*, Meek.

III. *Devonian.**

1. *Lingula*, Sp.
2. *Discina grandis*?
3. *Spirifer disjunctus.*
4. *Rhynchonella Stephani.*
5. *Streptorhynchus Chemungensis.*
6. *Palaeoneilo maxima.*
7. *Sanguinolites rigida.*
8. *Sanguinolites clavulus.*
9. *Sanguinolites ventricosa.*
10. *Mytilarca Chemungensis*
11. *Pteronites*, Sp.
12. *Pteronites*, Sp.
13. *Actinodesma recta.*
14. New and undt. form.
15. *Orthoceras crotalum*?

* The species in this were determined by Prof. James Hall.

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